ENCYCLOPÆDIA BRITANNICA.

EIGHTH EDITION.

THE

ENCYCLOPÆDIA BRITANNICA,

OR

DICTIONARY

OF

ARTS, SCIENCES, AND GENERAL LITERATURE.

EIGHTH EDITION.

WITH EXTENSIVE IMPROVEMENTS AND ADDITIONS;
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ENCYCLOPÆDIA BRITANNICA.

ANATOMY.

BOOK II.

DESCRIPTIVE, PARTICULAR, OR SPECIAL ANATOMY.

Special Anatomy.

Special Anatomy may be defined to be that science, the province of which is to determine the situation, shape, and component parts of the several textures and organs of which the human body consists. In the course of this, however, it is requisite to premise some observations on the external shape of the body, and the different regions into which it has, for the sake of greater precision, been divided.

The external shape of the human body is so well known, that it is superfluous to describe it. Besides its division into right and left halves, anterior and posterior surfaces, it is divided into head, trunk, and extremities. The trunk is subdivided into neck (*collum*), chest (*thorax, pectus*), and belly (*abdomen*). The extremities are subdivided into *thoracic* or upper, and *pelvic, abdominal*, or lower.

The shape of the head is ellipsoidal, or oblong spheroidal; the greater diameter being antero-posterior, and the transverse smallest. The neck is cylindrical, spreading out above and below. The shape of the trunk is that of an irregular cylinder, flattened before and behind, broad above, and tapering below the chest, but expanding again at the pelvis. The extremities affect the cylindrical form, inclining to the conical.

Distinction into regions.

These several parts may be still further subdivided. The head is distinguished into two great divisions, the head proper, and the face. The former corresponds to the scalp, and may be divided into coronal, temporal, parietal, and occipital regions. The coronal or syncipital may be reckoned from the anterior margin of the scalp to the site of the anterior fontanelle, or the line named the coronal suture. Behind this to the crown (*vertex*), and downwards on each side, are the parietal or lateral regions; from the parietal and frontal is the temporal; from the crown to the flexure of the neck is the hind-head or occipital (*occiput*); from the last point to the level of the shoulders is the *cervix*; on each side are the lateral regions of the neck; and before is the laryngeal, jugular, or anterior region of the neck (*jugulum*). The face consists of the brow, front or forehead (*frons*), with the *glabella* or *mesophryon* at its base, in the middle, and the eyebrows (*supercilia*) on each side; the nose (*nasus*), the upper lip (*supralabium*), the lower lip (*infralabium*), the chin (*mentum*), the cheeks (*genæ*), the chops (*buccæ*), the upper jaw (*mala*), and lower jaw (*maxilla*).

Besides these, it is usual to distinguish the *prolabium*, or the red portion of the lip, upper and lower, as covered by a thin half-cutaneous, half-mucous skin and epidermis.

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The chest, besides its distinction into right and left halves, anterior and posterior surfaces, and upper and lower boundaries, may be distinguished into a sternal region in the middle (*sternum*), a mammary region on each side, an axillary region, a costal region, a hypochondriac region, a scapular region, and a vertebral region.

Several of these regions it is convenient to subdivide in the following manner. The upper anterior region, immediately below the collar-bone, is distinguished as the subclavicular region; the space between the breast and the *axilla* as the extra-mammary region; that between the breast and the sternum as the intra-mammary region; the space below the breasts on each side as the infra-mammary region; the space below the armpit as the sub-axillary region. On the posterior surface of the chest, the space above the spine of the scapula is called the supra-spinal region; that below it the infra-spinal region.

The abdomen may be distinguished into regions in the following manner. The triangular space between the false ribs and navel, commonly named the pit of the stomach, is the epigastric region (*scrobiculus cordis, epigastrium*). Below this, in the centre, is the umbilical (*umbilicus*), with the iliac region or flanks, (*ilia*) on each side, and the hypogastric (*hypogastrium*) below. Behind, on each side of the vertebral column, are the loins, (*lumbi*).

Next to the abdomen is the pelvis, the posterior lateral parts of which are the buttocks (*nates*), the anterior, the *pubes*, and the inferior, the hips or ischiatic regions (*ischia*), with the *perinæum* in the middle between them.

In the trunk of the body, besides the chest, the abdomen, and the pelvis, it is proper to distinguish the region of the back-bone or spine, extending along the whole length of the trunk from the head to the lower end of the trunk. The spine or spinal region is divided into four subordinate regions; the cervical, the dorsal, the lumbar, and the sacral or sacro-coccygeal.

In each pectoral extremity are recognized the following division; the shoulder (*humerus*), the armpit (*axilla*), the arm (*brachium*), the elbow (*cubitus*), the fore-arm (*antebrachium*), the wrist (*carpus*), and the hand (*manus*). The latter is subdivided into the fore-wrist (*metacarpus*), the fingers (*digiti*), the palm (*vola*), and the back-hand (*thenar*).

Each abdominal extremity presents the following separate regions; the haunch (*coxa*), the thigh (*femur*), the knee (*genu*), the ham (*poples*), the leg (*tibia*), of which there is the muscular part or calf (*sura*), the ankle external and in-

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ternal (*malleolus externus et internus*), the foot (*pes*), subdivided into the ankle-joint (*tarsus*), the foot-joint (*metatarsus*), the toes (*digiti pedis*), with dorsal or upper surface, and plantar surface or sole (*solea*).

These divisions, though not so numerous as they have been made by some, are sufficiently so for the purpose of general anatomical description. Where more minute distinction is requisite, it shall be introduced as we proceed.

Descriptive or Special Anatomy includes not only the descriptions of the situations and relations of the different classes of textures in the human body and that of the internal organs, but it comprehends also a particular form of anatomical knowledge necessary to the surgeon. This consists in defining, as accurately as language and measurement can do, the boundaries of the different regions into which the human body may be divided, and ascertaining the positions and relations of all the important parts that are liable to become the seat of local disease and chirurgical operation. To this department the names of Chirurgical Anatomy, Topographical Anatomy, and Anatomy of Regions, are given.

The limits within which the present article must be confined permit not to enter upon this department of Anatomical knowledge. It is sufficient to say, that useful treatises on this subject have been published by Velpeau, Blandin, Edwards; and that in the systems of operative Surgery, especially that by Mr William Fergusson, and the work of Mr Maclise, correct information upon the boundaries and the relative positions of the various regions is communicated.

Stature.

The stature of the body varies in the two sexes, in individuals, in families, in tribes, and in nations. The Romans, when they first visited Gaul, remarked the gigantic stature of the ancient inhabitants of that country compared with themselves; and, generally speaking, the modern Italians, though by no means a pure or unmixed breed from the ancient stock, are a diminutive race. The Germans, and most of the English and Irish, are rather tall. The inhabitants of Finland are distinguished for their great stature, amidst the dwarfish tribes by which they are surrounded. In general the Europeans are taller than the Asiatics.

Height or length.

The average height of the adult male varies from 5 feet 8 inches to 5 feet 10 or 11 inches, or even to 6 feet. The dimensions of different parts vary according to those of the whole body; but the following measurements of a male of 5 feet 8 inches, and one of 5 feet 11 inches, may communicate some idea of the length of different regions of the body.

	Inches.	Inches.
Total height	68·00	71·00
Between the tips of the middle fingers, with the arms extended	68·00	72·75
From the crown to the pubes	34·00	45·00
From the crown to the lower tip of the chin	9·75	9·00
From the tip of the chin to the top of the breast	3·85	3·25
From the top of the breast to the pit of the stomach	6·08	9·75
Between the pit of the stomach and the navel	6·08	7·00
Between the navel and top of the pubes	6·08	6·75
Between the top of the shoulder and the bend of the elbow	12·06	12·00
From the bend of the elbow to the top of the hand	10·02	10·5
The hand, from the wrist to tip of middle finger	7·75	7·375
Between the top of the thigh inside and the knee inside	14·06	17·00
From the knee inside to the sole	18·05	20·00
The foot, from the heel to the point of the great toe	9·75	10·00

The average height of the female varies from 5 feet 3 inches to 5 feet 5 inches and 5 feet 7 or 8 inches. A woman of 5 feet 10 inches is unusually tall. The length of the different regions is proportionally less than in the male.

The length of the body previous to adult age varies with the period of life. The length of an embryo of three weeks, represented by Soemmerring, is about $\frac{1}{8}$ of an inch; one of eight weeks is about 1 inch; and one at the end of the fifth month is about 10 inches. According to Burns, however, the length of the fœtus in the fifth month does not exceed 6 or 7 inches; in the sixth it is about 8 or 9, in the seventh about 12, and in the eighth about 15 inches. At the period of birth, the average length, according to Roederer, is about $20\frac{1}{2}$ inches.

The only part of the fœtus of which it is important to determine the average dimensions at the period of birth is the head. Its largest diameter, which is that from the crown to the chin, is in general about 5 inches. The transverse diameter between the parietal protuberances is at the same time about $3\frac{1}{2}$ inches. Of 60 male and 60 female infants born at the full time, whose heads were measured by Dr Clarke, the circumference passing through the occipital process and the middle of the brow was at an average 13·8 inches, while the arch from ear to ear over the crown was 7·32 inches. One measured 15 inches in circumference, and one $8\frac{1}{2}$ inches from ear to ear; but none were under 12 inches in the one direction, or $6\frac{1}{4}$ inches in the other.

It is well established that there is a difference in the average dimensions of the male and female, even in the fœtal state. Roederer found the mean length of 16 male children born at the full time to be $20\frac{8}{12}$ inches, and of 8 females only $20\frac{4}{12}$; and of the 60 male and 60 female infants measured by Dr Clarke, the average circumference was 14 inches in the former, and only $13\frac{5}{8}$ in the latter; and the parietal arch was $7\frac{1}{2}$ in the former, and $7\frac{1}{5}$ in the latter. Of 120 infants, in 6 only, which were males, did the circumference of the head exceed $14\frac{1}{2}$ inches.

Weight.

The weight of the adult male varies from 9 stone to 11 or 12. Ten stones, or 140 lb., may be stated as the average. The female weighs about 8 stone, and rarely more than 10. After the age of 35 or 40, when fat begins to be deposited, the weight rises considerably; and the average weight at this age is from 13 to 14 stones. In some extraordinary examples of corpulence, combined with large stature, the weight of the body amounts to 20 and 25 stones.

The average weight of the fœtus in the early months is uncertain. According to Mr Burns, it weighs about 2 oz. in the 12th week; about 1 lb. in the 6th month; and about 4 or 5 lb. troy in the 8th month. At the period of birth the mean weight is about 7 lb. avoirdupois. Dr William Hunter states, that of several thousand new-born perfect infants weighed at the British Hospital in London by Dr Macaulay, the smallest was about 4 lb., the largest about 11 lb. 2 oz., and the greater number varied from 5 to 8 lb. avoirdupois. He knew no instance of a new-born infant weighing 12 lb. Of 60 male and 60 female infants weighed by Dr Clarke, the lightest was 4 lb., the heaviest 10 lb., and the average 7 lb. 13 dr. avoirdupois. The average weight of 26 children at the natural period, weighed by Roederer, was about $6\frac{1}{2}$ lb.; the lightest about $5\frac{1}{2}$ lb. and the heaviest about 8 lb.

The difference between the weight of the male and female infant at birth is estimated by Dr Clarke at about 9 oz. avoirdupois, which agrees with the results obtained by Roederer.

In the case of *twins*, the average weight of each twin is in general less than that of children born at single births; but the combined weight of both is greater. Dr Clarke found the average weight of 12 twins to be 11 lb. avoirdupois each pair; the heaviest being 13 lb., and the lightest $8\frac{1}{4}$ lb. Mr Burns, however, states that he has known instances in which

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each twin was rather above than below the usual weight of a single-birth child.

Average weights of Individual Organs.

An important and useful point is to determine the average size and the dimensions of the principal organs of the human body in the adult state. Krause has, with this view, given the measurements of all the regions and the dimensions of most of the organs. All these modes of estimating the size of organs, however, are fallacious. The only one which can be employed with any precision is to ascertain the average weights of organs, and to note the proportion which these weights bear to that of the whole body. Attempts of this kind, applying, however, only to certain organs, have been made by different inquirers.

The organs specified were found, according to numerous trials made by Dr Clendinning, in males between the ages of 21 and 60 years, to weigh on an average, at the following rates:—

	Oz.		Gr.		Lb.	Oz.
Brain................	$46\frac{1}{4}$	=	20,226	=	2	$14\frac{1}{4}$
Heart................	$9\frac{1}{16}$	=	3,982			
Liver................	$53\frac{1}{2}$	=	23,408	=	3	5
Kidneys.............	$9\frac{1}{5}$	=	4,025			
Spleen	5	=	2,188			
Pancreas	$2\frac{5}{8}$	=	1,148			
Stomach	5	=	2,188			
Lungs	46	=	20,116	=	2	14

In the same persons the whole person weighed $94\frac{1}{2}$ pounds, which is between 46 and 48 pounds less than the average, 140 or 142 pounds (Quetelet), at the age of 40 years.

Among the persons weighed, however, several were 124, 125, and 126 lb.; two weighed 140 lb., one weighed 133 lb., and one at 50 years weighed 200 lb.

These results differ in a very slight degree from those obtained by Dr Reid and Dr Peacock in the Royal Infirmary, Edinburgh. In 89 males the average weight of the heart amounted to 11 oz. 1 dr.; in 53 females to 9 oz. $\frac{1}{4}$ dr. In 60 males the average weight of the liver was 52 oz. $12\frac{1}{2}$ dr.; in 25 females 45 oz. $3\frac{1}{4}$ dr. The right kidney weighed, on an average in the male 5 oz. 7 dr.; in the female 14 oz. 13 dr. The left kidney 5 oz. 11 dr. in the male; in the female 5 oz. 2 dr.

The average weight of the whole brain (*Enkephalon*) in 131 males, between the ages of 25 and 55 years, was found to be 50 oz. $3\frac{54}{131}$ dr.; in 74 females between the same periods to be 44 oz. $14\frac{28}{74}$ dr.; giving a difference of 5 oz. 4·95 dr. in favour of the male brain.

The average weight of the brain proper (*Cerebrum*) in 95 males between the ages of 25 and 55 years, was found to be 44 oz. 3·4 dr.; in 58 females within the same periods to be 39 oz. 3·3 dr.; making a difference of 5 oz. 0·1 dr. in favour of the *cerebrum* of the male.

Special Anatomy has been divided, according to the classes of textures of which the human body is composed, into different parts, with appropriate denominations. Thus the anatomy of the bones has been named *Osteology*, *Osteography*, and *Skeletology*; while that of the soft parts in general has been denominated *Sarkology*. Where more minuteness is attempted, the anatomy of the soft parts has been still further subdivided into that of the ligaments, *Syndesmology*; the muscles, *Myology*; the vessels, *Angiology*; the nerves, *Neurography* and *Neurology*; the membranes, *Hymenology*; the glands, *Adenography* and *Adenology*; and the internal organs, *Splanchnology*.

Though these are convenient terms to designate the several divisions of Special Anatomy, they afford little assistance in the general arrangement of the subject. It is justly observed by Bichat, that this arrangement, if such it can be named, is objectionable, by separating different organs which ought to be united. It is indeed remarkable only for connecting organs by arbitrary, and often unnatural principles; and though it may answer in a subordinate manner, it is unfit to furnish the principles of a general and natural mode of arrangement.

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The most eligible method is that which arranges the organs according to their physiological purposes,—a method adopted by Haller and Soemmering, but which required the hand of Bichat to give it its full and perfect developement, and which has since been adopted from this author by most subsequent writers.

According to this method, the organs of the human body may be arranged in three great classes: *first*, those pertaining to the animal functions, or which establish the connection between the individual and the objects of the external world—the organs of *relation*; *secondly*, those pertaining to the organic functions, or which tend to the continuance of the individual—the organs of *nutrition*; and, *thirdly*, the organs relating to the continuance of the species—the organs of *reproduction*. The first class contains the organs of locomotion, speech, and sensation; the second those of digestion, circulation and absorption, respiration, and secretion; and to the third are referred the organs of generation.

This method may not be altogether free from objections; several of which are anticipated by Bichat. It is sufficient, however, to observe that it is less objectionable than any other; and one of its advantages is, that it furnishes a clearer and more precise idea of the connection of the different classes of organs of the animal body than any other yet proposed.

This method of arrangement may be conveniently exhibited in the following table.

I. *Organs pertaining to the Animal, Voluntary, or Relative Functions.*

1. Locomotion.	Instruments—Bones, Cartilages, Ligaments, and Fibro-cartilages. Agents—Muscles, Tendons, and their appendages.
2. Sensation.	The Organs of Proper Sensation—Smell, Sight, Hearing, and Taste. The Organs of Common Sensation—Touch, Tact, &c.
3. Voice.	Laryngeal Voice—the Larynx. Oral Voice or Speech—the Lips, Tongue, and Teeth.
4. Nervous Energy, or Innervation.	Central Organs—Brain, Cerebellum, and Spinal Chord. Distributed Organs—the Nerves.

II. *Organs pertaining to the Organic or Nutritive Functions.*

1. Alimentary or Limitrophic Function.	Digestion.	Mastication—Mouth, Tongue, and Teeth. Deglutition—Pharynx and Œsophagus. Chymification—Stomach. Chylification—Duodenum and Ileum. Defecation and Excretion—Colon and Rectum.
	Lacteal Absorption—Lacteals and Thoracic Duct.	
2. Circulation.	Nutritive Circulation—Heart and Blood-vessels. Aerating Circulation, or Respiration—Lungs, &c. Secretory Circulation, or Secretion—Glands.	

III. *Organs pertaining to the Reproductive Function.*

Generation.	Male or Impregnating Organs. Female or Ootrophic Organs.	Product—the Fœtus.

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PART I.

ANATOMY OF THE ORGANS OF THE ANIMAL, VOLUNTARY, OR RELATIVE FUNCTIONS.

The organs belonging to the functions of animal life are those of locomotion, sensation, voice, and innervation. These organs are distinguished by two general characters, symmetry of form and harmony of action. By the first is meant that each organ possesses similar parts on each side of the mesial plane. By the second is meant that the action of that part which is on the right side of the mesial plane corresponds with that on the left.

CHAP. I.—THE ORGANS OF LOCOMOTION.

The organs of locomotion may be arranged in two orders, active and passive. The first are the agents of motion, or the organic substances which produce motion; the second are the bodies moved, or the instruments of motion. The muscles, strictly speaking, are the former, though to these are added certain appendages. The bones and their appendages constitute the second.

With the latter order of parts it is usual to begin the business of special anatomy, for obvious reasons. The bones are at once the most durable and regular in shape of all the organic solids; and as an intimate relation subsists between their mechanical figure and the soft parts connected with them, the knowledge of the former constitutes the best introduction to that of the latter species of organs.

SECT. I.—OSTEOLOGY, SKELETOLOGY.

The assemblage of bones composing the human body constitutes the skeleton, which, like the body, is divided into head, trunk, and extremities. The length of the skeleton is about an inch less than that of the body; that is, the skeleton of an individual 5 feet 8 inches in height is about 5 feet 7 inches long, and of one 6 feet, about 5 feet 11 inches long. The weight of the skeleton varies at different periods of life. That of a middle-sized adult ranges between 160 and 200 ounces. A male skeleton, measuring 5 feet 6 inches long, I found to weigh 168 ounces, or $10\frac{1}{2}$ lbs., avoirdupois.

The number of separate pieces amounts to 254, of which 56 belong to the trunk, 60 to the head, 72 to the pectoral extremities, and 66 to the pelvic. Of these several parts, the trunk is the most important, because, 1*st*, it is developed before the head or extremities; and, 2*dly*, because if we look to its place in the animal kingdom generally, it is the most essential and constant, and presents the general *modulus* or type according to which the osseous pieces composing the head are constructed.

The Trunk.

The trunk. The trunk of the skeleton consists of three parts, the spine or vertebral column, the chest or thorax, and the pelvis.

§. 1. *The Spinal or Vertebral Column.* (*Spina Dorsi; Vertebræ.*)

The vertebral column. The vertebral column, situate in the posterior part of the trunk, the length of which it determines, unites the head to the pelvis, supports the former, and is supported by the latter. When completely developed, it consists of 29, and rarely of 30 pieces, named *vertebræ* (*spondyli*, *σπονδυλοι*), from the circumstance that each admits of a slight degree of rotatory motion. Twenty-four of these bones, which are in the healthy adult separate, are denominated true vertebræ (*vertebræ veræ*). The 25th, named the *sacrum*, though in adult life forming a single bone, consists in early life of four separate pieces, which become consolidated, and are therefore named false *vertebræ*, (*vertebræ spuriæ*). The four last constitute what is named the *coccyx*. The column thus formed, though straight at birth, assumes afterwards several curvatures in the antero-posterior direction, giving it the aspect of the Italian *ʃ*. It may be divided into four regions, the cervical, dorsal, lumbar, and sacral. In the first it is almost straight, but begins to bend backward in the second, so as to form a considerable curvature with the convex surface posteriorly. A little below the middle of the dorsal portion it bends forward, and continues to do so to the lower part of the lumbar region, where it once more bends backward, and forms the sacrum into a concave hollow. At the lower end of the sacrum it again inclines forward, and the coccyx is in general considerably incurvated anteriorly. (Plate XXVI. fig. 1.)

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The vertebræ.

Besides the antero-posterior curvatures, there is in general a lateral one near the lower part of the dorsal region, on the left side, to which its concavity is directed. This has been observed by anatomists, from Cheselden, who first represented it, to Soemmering, Bichat, and Meckel.

In length the vertebral column does not vary much; and differences in stature depend more on the dimensions of the members than of it. In thickness it augments progressively from the cervical to the sacral portions, after which it once more tapers to a point. It may be compared to two cones united by their base, the superior of which is truncated.

The vertebræ, true and false, possess certain common characters. Of these the most general is the annular shape, or a ring of bone, the opening of which, in continuity with those of the whole column, constitutes a longitudinal cylindrical cavity for lodging the spinal chord and its envelopes. It is therefore denominated the hole of the spinal marrow (*foramen medullæ spinalis*, Soem.), or simply the vertebral hole (Bichat). Anterior to this is a mass of bone, generally the largest of the vertebra, and therefore named its body (*corpus vertebræ*). The anterior surface is flat, sometimes slightly convex; the posterior is always concave; the upper and lower surfaces are slightly concave, and correspond with the intervertebral fibro-cartilages.

Behind the hole the vertebra is moulded into an arch or annular segment, the outer surface of which forms seven processes. The first at the back of the vertebra on the median line is the *spinous process*, which may be said to be formed by the union of the spinal plates in the middle. On each side are two, which, from their situation with respect to the column, are named *transverse* processes. Other four, two on the upper and two on the lower surface of each vertebra, near the base of each transverse process, are named *oblique*, from their direction, and *articular* (*processus articulares*), because the inferior ones of the superior vertebra are articulated with the superior ones of the lower vertebra. These processes are easily distinguished by being covered with cartilage and synovial membrane. They constitute true capsular joints.

Each vertebra presents four notches or depressions, two at the upper and two at the lower surface, between the body and the oblique processes. Each of these, with corresponding notches on the vertebra above and below, forms a hole (*foramen conjunctionis, vel intervertebrale*), for the exit of the spinal nerves and the entrance of blood-vessels.

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The vertebræ.

All the vertebræ, excepting the *atlas* and *vertebra dentata*, are united in the same manner, and at the same points. The bodies are united by the intervertebral fibro-cartilages, which consist of white concentric annular layers of fibrous matter, placed in juxtaposition, and containing internally semifluid jelly. In adults this substance becomes firm and consolidated; but in the young subject it is so soft and compressible, that young persons are found to be one or two inches taller in the morning, or after they have been some time in the recumbent position, than in the evening, or after the spinal column has sustained for some hours the weight of the person. In advanced life these fibro-cartilages become still more solid and shrivelled; and in some instances they are converted into bone, so as to unite two or more vertebræ in a single mass. This change is one reason of the greater stiffness and incurvation of the spine in the old and decrepid, than in those in early life.

Besides the connection by the intervertebral cartilages, the vertebræ are united at their articular processes by means of capsular ligaments, so as to allow slight flexion and extension on each other; and at the basis of the spinous processes, by means of short, firm, and inelastic yellow chords (*ligamenta flava*), named yellow ligaments. These, with a thick fibrous fascia extending along the anterior surface of the bodies (*ligamentum anterius, fascia longitudinalis anterior*), a similar fibrous fascia behind, lining the vertebral canal, a ligament connecting mutually the apices of the spinous processes, and the incumbent muscles, retain the vertebræ firmly in their places, and prevent them from being dislodged, unless by a force adequate to break the bones and rend the ligaments.

The vertebræ vary in structure. The bodies consist chiefly of loose cancellated tissue, without solid bone. The spinal rings and the processes are much more firm and dense.

In the fœtus and infant each vertebra consists of three portions, a thick, loose mass, corresponding to the body, and two lateral arches corresponding to the spinal rings, without spinous process, and scarcely meeting. In the fœtus, indeed, the posterior wall of the vertebral canal may be said to be incomplete. Soon after birth, however, the spinal plates enlarging, mutually coalesce on the median line; and from this point of union, by successive accretion, the spinous processes are gradually formed. These facts may serve in some degree to explain the facility with which tumblers and rope-dancers may be habituated in infancy to the most extraordinary inflexions of the trunk.

The vertebræ, agreeing in the characters now enumerated, differ from each other according to the regions which they occupy, and the parts with which they are connected. On this principle the twenty-four true vertebræ are arranged in three classes; the cervical (*v. cervicis*), the dorsal (*v. dorsi*), and the lumbar (*v. lumborum*).

The cervical vertebræ are in number generally seven, rarely six or eight; the dorsal are twelve; and the lumbar are five. (Plate XXIV. and XXV. fig. 1.)

The cervical vertebræ.

The cervical vertebræ are distinguished by their bodies being small, with flat anterior surfaces; by the articular processes being short and flat, as well as less oblique than those of the others; by their transverse processes being short, of a triangular shape, hollowed above, and perforated at the base by a hole for the transit of the vertebral artery; by the spinous processes being short, nearly horizontal, and generally bifid; and by the vertebral hole being large and of an oval shape.

The atlas.

The first and second of these vertebræ are still further distinguished by peculiarities of configuration. The first, which is named *atlas*, consists of a large bony ring, inclosing an irregular hole, approaching to the shape of the ancient lyre. Instead of the body, which is wanting, is a mere arch of dense bone, with an obtuse tubercle before for the *longus colli* muscle, and behind an articular facette which applies to a corresponding one of the tooth-like process of the second vertebra. From the extremities of this arch the vertebral hoop acquires considerable thickness, for the formation of the oblique and transverse processes. The superior oblique process is seen above on each side in the form of an elliptical cartilaginous surface, slightly concave, consisting of two parts, the anterior large, the posterior small, and terminating in a point which overhangs the sinuosity of the vertebral artery. The cavity of this superior oblique process receives the condyloid process of the occipital bone, with which it is connected by a capsular ligament, lined by synovial membrane. Below is seen the articular facette of the inferior oblique process, rounder, shorter, less concave, but covered also by cartilage and synovial membrane, and articulated with the superior processes of the second vertebra. Between these two, on the lateral regions of the vertebral ring, is the transverse process, in the shape of a triangle, the base of which is formed by the bone of the oblique processes, and the sides by the production of the anterior and posterior arch. The latter, being the segment of a smaller circle, is more distinctly circular than the former, and may be described as a strong, dense, semiannular piece of bone, with a tubercle on its posterior margin at the median line, to which the *rectus capitis posticus minor* is attached. On the inside of the atlas, at the lower margin of the superior oblique process, is a rough surface with a depressed cavity, which marks the insertion of the transverse ligament. The space anterior to this is occupied by the tooth-like process of the second vertebra; that posterior to it, which is the proper vertebral hole, by the beginning of the spinal chord.

The atlas is connected above to the occipital bone by the capsular ligament, which surrounds the margins of the superior oblique processes; below, to the *vertebra dentata* in the same manner; and behind its anterior arch to the tooth-like process. To its anterior tubercle are attached the *longus colli* and *rectus capitis internus minor*; to the transverse process the *rectus lateralis*, the superior and inferior oblique muscles, the *levator anguli scapulæ*, the *transversi*, the *scalenus anticus*, and the *transversus colli*. To its posterior arch the *rectus posticus* is attached.

By the condyloid processes of the occipital bone moving on the superior oblique processes, the head is bent and extended, or moved backwards and forwards on the atlas.

The atlas ossifies by two points.

The axis.

The second vertebra, named *axis* and *epistropheus*, from its motions, is distinguished by a large prominent body like a tooth (*processus odontoides*) issuing vertically from its body, a circumstance from which it is also named *vertebra dentata*. This process, which is a four-sided prism, with the top obliquely acuminated, presents on its anterior surface an articular facette, corresponding to that of the atlas. The posterior surface is rough, and corresponds to the transverse ligament. From the odontoid process the body descends somewhat below the level of the vertebral hoop, and presents at its lower margin, on the median line, a tubercle, with excavations on each side. Above, on each side of the odontoid process, are the superior oblique processes, in the shape of oval facettes, covered by cartilage and synovial membrane, and articulated with the inferior oblique processes of the atlas. Below, and a little behind, is the inferior articular process, more oblique in direction, and articulating with that of the third vertebra. Between the two is the transverse pro-

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cess, with the vertebral hole in its base; and from the same point the spinal plates converge backwards so as to form the spinous process, which is distinct and bifid in this vertebra. Between the superior oblique process is the upper notch, which is rather a rounding of the spinal plates than a distinct depression; and between the inferior oblique process and the transverse process is the lower notch, which, with the upper one of the third vertebra, forms a complete hole for the exit of the fifth pair of spinal nerves.

The vertebral hole in this vertebra is heart-shaped, the basis before and the apex behind.

By the odontoid process it is articulated with the occipital bone and the atlas; by the upper oblique process with the atlas; and by the lower oblique process with the third cervical vertebra.

To the transverse process are attached the *splenius capitis, levator anguli scapulæ, scalenus, transversus cervicis, longus colli, intertransversalis secundus anterior et posterior.* To the spinous process are attached the *rectus capitis posticus major, obliquus inferior, spinalis cervicis, interspinalis cervicis,* and *multifidus spinæ.*

The axis ossifies from four points, one for each side, one for the body, and one for the odontoid process.

The third, fourth, fifth, and sixth cervical vertebræ are very similar. The bodies gradually increase in size to the seventh, which is generally the largest. The articular processes are also more oblique in the lower ones than in those above. The spinous processes also increase in size in the lower cervical vertebræ, and in the sixth and seventh are particularly large and prominent; and in the last are not bifid, but merely tubercular. The vertebral holes in the second and third are heart-shaped, and the lower ones triangular, with the apex towards the spinous processes. The body of the seventh also presents at its lower margin a depression, which, with a corresponding one in the first dorsal, receives the head of the first rib. The seventh, in short, may be regarded as indicating the transition from the cervical to the dorsal vertebræ.

Besides the muscles already mentioned as attached to the *axis,* to the cervical vertebræ are attached the *lumbo-costalis,* the *serratus posticus superior,* the *rhomboideus minor,* the *cucullaris,* the *splenius capitis,* the upper part of the large *complexus,* and part of the *rhomboideus major.*

The dorsal vertebræ.

The dorsal or thoracic vertebræ (*v. dorsi vel thoracis*), which are twelve in number, are distinguished by articular notches on their superior and inferior margins, which, with the intervertebral cartilage and the contiguous vertebræ, form depressions for lodging the heads of the ribs, and cartilaginous facettes on their transverse processes for articulating with similar facettes on the tubercles of the ribs. The tenth dorsal vertebra has often only one facette above, and the eleventh and twelfth have only a single facette for each of the two last ribs.

The bodies of the dorsal vertebræ are more convex and somewhat rounder before than those of the cervical and lumbar. The hole, which is smaller, is also rounder, approaching to the oval shape.

The spinal plates are broad and strong, and meet behind in long prismatic spinous processes, which are directed obliquely downwards, so that they are imbricated over each other, especially in the middle of the back. The three last are less oblique. The oblique direction and imbricated arrangement of the spinous processes are connected with the peculiar flexuous bend which the column undergoes from the lower part of the cervical to the upper end of the lumbar region.

The twelfth dorsal vertebra approaches the first lumbar in the large size of its body, in the shortness of its transverse processes, in the straight direction and smaller extent of the spinous process, and in the articular processes becoming almost vertical.

To the dorsal vertebræ the following muscles are attached: the *splenius capitis et colli, trachelo-mastoideus,* the part of the *complexus* called *biventer cervicis,* the *complexus, longus colli, transversus colli, spinalis colli, semispinalis dorsi, multifidus spinæ,* the inner part of the *lumbo-costalis,* the *levatores costarum,* the inner layer of the tendon of the internal oblique and transverse muscles of the belly, the *latissimus dorsi, rhomboideus major, cucullaris,* and *serratus posticus superior et inferior.*

The lumbar vertebræ.

The five lumbar vertebræ are distinguished by the size of their bodies and their processes, and by the direction of the spinous and articular processes. Each body is both broader and thicker, but less convex, than those of the dorsal vertebræ. The vertebral hole also is larger, and it resumes the triangular shape as in the neck. The transverse processes are broad, flat, and large, without articular facette like the dorsal, or arterial hole like the cervical, and are rough by the attachment of the *sacro-lumbalis.* Of the articular processes, which are large and have a vertical direction, the upper is concave, oval, and turned towards the median plane; the lower is convex, oval, and directed towards the lateral regions. The spinous processes are large, flattened, almost square, with thick obtuse margins, and directed straight backwards. The vertebral notches are large, and form holes much larger than at any other part of the spine.

The attached muscles are the *spinalis dorsi, multifidus spinæ, quadratus lumborum,* the inner layer of the internal oblique and transverse, and the outer layer of the latter, the external and internal parts of the *lumbo-costalis,* the *latissimus dorsi, serratus posticus inferior,* the diaphragm, and the *psoæ.*

The sacrum.

The *sacrum,* composed in early life of five pieces, which are afterwards consolidated into one, may be regarded as a series of imperfect vertebræ conjoined into a single mass. It is a symmetrical bone, of a triangular shape, with the base attached to the last lumbar vertebra, the apex, which is obtuse, adhering to the *os coccygis,* and the sides wedged between the bones of the pelvis.

The anterior or pelvic surface is concave, with the base, sometimes named the *promontory,* prominent and overhanging, the apex and the lateral margins incurvated forwards, and corresponds to the rectum. It presents in general four, sometimes five pairs of oval holes, which communicate with the spinal cavity, and between each of which may be seen a transverse ridge marking the lines of junction of the several bones; and in some instances the inner is so imperfect that a deep line is left. These holes, therefore, through which the nerves pass from the spinal chord, are quite analogous to those formed by the union of the vertebral notches. The posterior surface of the sacrum is much more irregular. At the top are two articular processes, concave and cartilaginous, for receiving the convex surface of the inferior articular processes of the last lumbar vertebra. Outside of these is a deep notch, which, with that of the same vertebra, forms the posterior vertebral hole; and outside of this is a tubercle, which corresponds to the transverse processes of the true vertebræ. Below the notch on each side is a series of four holes, which, like those of the anterior surface, communicate with the cavity of the bone, and allow the posterior nerves to issue from the chord. On the median line, between, there is an irregular bony ridge, or rather a series of three spinous processes, short, obtuse, and separated by shallow depressions. The third of these diminishes gradually in the longitudinal direction till it is entirely lost

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opposite the fourth pair of sacral holes, leaving between two ridges a triangular opening, which often communicates with the interior of the spinal cavity, and, when it does not, marks the lower termination of that cavity. In the former case it is closed by the posterior sacro-coccygeal ligament.

The sides of the sacrum, which are rough, and of an irregular cuneiform shape, present two surfaces,—one anterior, something cartilaginous, for articulating with the iliac bones,—the other posterior, marked by two deep sinuosities, in which are lodged the sacro-iliac ligaments. The inferior termination of the sides tapers towards the apex or coccygeal end. The surface is rough for the insertion of the sacro-ischiadic ligament, and it is terminated by a notch for the exit of the fifth pair of posterior sacral nerves.

The structure of the sacrum, like that of the vertebræ, is cancellated, and most loose in the site of the spinal plates and processes. Its mode of ossification is analogous to that of the vertebræ generally. On the middle plane appear five points, which correspond to the bodies of the false vertebræ, or the individual bodies of the sacrum; and on each side of these are formed two others, which become eventually the ridges of bone between the anterior and posterior sacral holes and the spinal plates. As these enlarge, they coalesce; and consolidating, leave only on the pelvic and dorsal surfaces the rows of holes through which issue the sacral nerves. It hence results that the sacrum is ossified from fifteen separate portions of bone.

Besides the muscles connected with the lumbar vertebræ, the sacrum gives attachment to part of the *glutæus maximus* and the *pyriformis*.

The *sacrum* is attached above to the last lumbar vertebra by the intervertebral fibro-cartilage, the capsule of the two articular processes, and the yellow ligament of the spinous processes; to the iliac bones by the sacro-iliac *synchondrosis*, and to the coccyx by a similar fibro-cartilage. (Plate XXIV. fig. 1, S.)

The os coccygis.

The *coccyx* is a symmetrical bone, triangular, occupying the posterior and inferior parts of the pelvis, attached by its base to the sacrum, and with the apex free and slightly incurvated forwards, so as to terminate in a hooked point, which has been supposed to resemble the bill of the cuckoo, (*κοκκυξ, cuculus.*)

The anterior or pelvic surface is concave, marked with transverse grooves covered by periosteum, and supporting the lower extremity of the rectum. The posterior or outer surface is convex, gibbous, and unequal, for the insertion of the sacro-coccygeal ligament and some fibres of the large *glutæus*, and, like the anterior, is also marked by transverse grooves.

The base or upper end of the coccyx is concave before for articulation with the sacrum, and presents behind two tubercles continuous with those of the spinal region, and on the sides two notches, which, with those of the sacrum, form holes for the fifth pair of sacral nerves. The margins of the bone are rough, for the attachment of the small sciatic ligament, and meet below at an angle, which is sometimes bifid, sometimes obtuse, and to which the *levator ani* is attached.

The coccyx is generally cellular, with little density. The transverse grooves by which it is marked indicate its original separation into five portions, two of which becoming united, leave four and occasionally three portions, an upper, a middle, and a lower. These portions, indeed, are so long in consolidating, that they are often separate in the adult. The first is the largest, and resembles a diminutive vertebra without hole, and with truncated or undeveloped processes. A lateral portion on each side projects like a wing, the rudiments of the transverse processes; and the two tubercles above noticed, rising like horns, are imperfect articular processes, meeting those of the *os sacrum*. The bony ridge which descends from these are imperfect spinal plates; and as these do not meet, they leave between them a groove corresponding to the anterior half of the vertebral hole; and the spinous processes are wanting. In the second coccygeal bone, which is rounder than the first, the aliform portions corresponding to the transverse processes are also smaller than in the first; and in the third and fourth they are diminished so much that they are scarcely cognizable.

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The spine.

The spine generally.

The series of bones now described form by their union what is called the backbone, chine, spine (*spina dorsi*), or vertebral column. Viewed in connection, it may be distinguished into an anterior and a posterior region, two lateral surfaces, a base, and an apex.

The anterior region is large in the neck, narrow in the back, and broad in the loins and pelvis. A series of transverse grooves of variable depth marks the bodies of the vertebræ; and a series of transverse elevated ridges distinguishes in like manner their upper and lower margins. These grooves, which in the cervical vertebræ are confined to the front, extend in the dorsal and lumbar to the sides. This anterior region is covered by the anterior vertebral ligament. On the sides it answers in the neck to the anterior or great *recti*, and the *longi colli* muscles; in the chest to the latter, to the *vena azygos* on the right, and the thoracic aorta on the left; in the abdomen to the abdominal aorta and the inferior cava; and in the pelvis to the rectum.

In the posterior region are seen, on the mesial plane, the row of spinous processes, horizontal above and below, and imbricated in the middle. The intervals, which are considerable in the neck and loins, are much contracted in the back, in which extension brings the processes in contact. The apices of all are in general in the same straight line; but this may be disturbed, either from the wrong direction of a process, or an unnatural position of a vertebra.

On each side are seen the intervertebral grooves (*fissuræ interspinales*), which commence at the occipital bone, and are continued with those of the sacrum. Broad and horizontal above, smaller and more oblique in the middle, very narrow below, these grooves are formed by the series of spinal plates, between which are left spaces varying in size according to the obliquity of the plates. These spaces are occupied within by the yellow ligaments, which being inserted at their inner surface, are something broader than the spaces, and without by the *transversus spinæ* muscle.

On each side also is recognised a longitudinal hollow, extending from the atlas to the lower end of the sacrum. This hollow, which is formed by the spinous processes and the transverse processes with the spinal plates below, is superficial at the neck, narrow and deep in the back, and narrow and superficial at the loins and sacrum. In this longitudinal groove is lodged the muscle named *multifidus spinæ*. (Plate XXV. fig. 1.)

The lateral regions present first the row of transverse processes, which vary in direction in different regions, chiefly in consequence of the spinal curvatures. Thus, if a vertical plane pass down along the sides of the column, the transverse processes of the neck and loins will be anterior to it, while those of the back will be behind it. In the first region these processes are distinguished for forming, by the series of holes in the base of each, a bony canal traversed by the vertebral artery, and which is com-

pleted in the intertransverse spaces by the *intertransversales colli.* To these transverse processes numerous muscles are attached. Between them in the neck, and anterior to them in the back and loins, is a series of holes formed by the union of the vertebral notches. Through these, which are the intervertebral holes (*foramina intervertebralia*), and which increase in size from the neck to the loins, where they are considerable, the anterior branches of the spinal nerves pass. Their shape is elliptical and their transit short. Anterior to these processes in the dorsal vertebræ are the depressed facettes, in which, with those of the fibro-cartilages, the heads of the ribs are lodged.

The base of this column, which is supposed to be the last lumbar vertebra, is articulated with the sacrum in such a manner as to form an anterior convexity and a cavity behind. The base, however, may with greater justice be placed in the upper half of the sacrum, which, being firmly wedged between the thick posterior margins of the iliac bones, transmits to them, and thereby to the bones of the pelvic extremities, the weight of the trunk. The mechanism of this is similar to that of the keystone of an arch, which the sacrum truly represents. The perpendicular pressure on this bone is counteracted and balanced by the lateral pressure of the iliac bones; and this lateral pressure is sustained, partly by their mutual pressure on each other before at the pubis, but chiefly by the oblique pressure of the neck of the thigh-bone, and the perpendicular pressure of the cylinder of the latter and those of the leg-bones.

The upper extremity of the column, which is formed by the atlas and axis, receives the weight of the scull and its contents, which are exactly balanced on the articular cavities of the former bone. On this also the head is bent or extended by its proper muscles. Rotation is performed by the motion of the atlas with the head on the articular cavities of the second vertebra, and round its odontoid process.

The holes of each vertebra form, by union, the vertebral canal, in which are lodged the spinal chord, the origins of its nerves, and its membranous coverings. This canal, which is continuous with the cavity of the scull by means of the occipital hole above, and is completed by the sacral canal below, is not in the centre of the spine, nor is everywhere of the same dimensions. Situate behind the vertebral bodies, and before the spinal plates, it is nearer the posterior than the anterior region of the column. Large at the neck and upper part of the back, it diminishes below, and again enlarges in the loins. Its area is triangular in the cervical region, oval in the dorsal, and triangular again in the lumbar and sacral regions. It follows the different curvatures of the spinal column. In the recent state, it is formed not by the bones only, but before by the intervertebral cartilages, and behind by the yellow ligaments and the *interspinales* and *intertransversales* muscles. Lined by periosteum, by the posterior vertebral ligament, and by a quantity of loose cellular tissue, it is further covered by a cylindrical fibrous membrane, similar to the *dura mater*, the outer investment of the spinal chord; and within this are contained the *ligamentum denticulatum*, the spinal arachnoid, and the spinal chord itself, with its anterior and posterior nervous roots on each side, and its appropriate blood-vessels. In early life the soft parts predominate; and the canal and its component bones are then susceptible of much freer and more extensive motion than afterwards, when ossification is complete, and the fibro-cartilages acquire firmness.

In the human subject it may be viewed as a firm but flexible bony cylinder, which performs several functions at once. Resting on the sacrum, which is wedged immovably between the iliac bones, it supports the trunk in the erect position, and transfers to the sacrum, on which it rests, the weight of the head, the chest, and great part of the abdomen. In the vertebrated animals in general it incloses the spinal chord, one of the most essential and constant parts of the nervous system. In the several regions it forms a sort of posterior protecting wall to several important vital organs. Thus, in the neck it forms a posterior barrier to the œsophagus, the windpipe, and the great sympathetic. In the back it constitutes the posterior wall of the chest; and in the loins and pelvis it is the posterior wall of the abdominal viscera and the large vessels.

In answering these ends, it is important to remark, that the firmness and mechanical arrangement of the spinous processes are of essential service. Their imbricated arrangement renders it impossible for any foreign body to enter the vertebral cavity and injure the spinal chord, unless between the occipital bone and atlas, or between the atlas and axis; and even at these points much precision is requisite to enter the cavity. Between the axis and the third vertebra it is more difficult, and below this next to impossible, without breaking the spinous processes.

With this character of security and support, the vertebral column unites a high degree of flexibility. Though the degree of motion between each vertebra is trifling, yet between several it is considerable, and between the whole twenty-four it is multiplied to a great amount. The motions of which the vertebral articulations admit are those of flexion and extension, rotation, and lateral flexion. Of these, flexion is that which is most extensive; for in the anterior direction there is less impediment to the motion of the vertebræ than behind, where the spinous processes allow no great extent of motion, unless where the habit has been acquired in early life, before ossification is completed. The rotatory motion of one vertebra on another is small; but by combining the motion of several or of the whole column, it becomes so extensive that some individuals can turn the head and neck more than half round. That these motions are the passive result chiefly of the intervertebral cartilages and the articulations of the oblique processes, may be inferred from the fact, that when the former are ossified, or the latter ankylosed, the motions are much impaired generally, and wholly destroyed in the vertebræ affected.

The motions of the head on the atlas have been already shortly noticed. Those of the atlas and occipital bone on the axis are, though simple in effect, complex in mechanism. The motion, indeed, is limited to that of rotation; but this rotation is extensive. This is favoured by the horizontal position, and the large extent of the inferior articular processes of the atlas, and the superior ones of the axis, the looseness of the articular capsule, and the absence of spinous process in the atlas. The axis and its odontoid process becoming the fixed point, the atlas, and with it the occipital bone and scull, turn on the elliptical flat articular surfaces, and on the odontoid process. On the first they glide extensively, and in opposite directions, while the capsular ligaments are stretched. On the odontoid process the motion is more limited, and from right to left, and conversely; and in the latter variety of motion, the arch of the atlas before, and the transverse ligament behind, move on the anterior and posterior facettes of the odontoid process.

The anatomical construction of this articulation, however, which is so favourable to extensive motion, is attended with the disadvantage of facilitating the luxation of the atlas on the axis. Luxation, indeed, may be re-

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garded as produced by too extensive motion of these bones, in which the articular processes of the former vertebra abandon those of the latter, and instead of resting on them, are placed on the same plane, while the spinous processes are separated at least half an inch. It may be further observed, that the want of fibro-cartilages between these bones before, and of yellow ligaments behind, is favourable to displacement. The effect of this change of position on the spinal chord is obvious. While the one side of the atlas is thrust off the axis, the other is forced so near its body and articular process, that it compresses the spinal chord, and may occasion palsy or immediate death, by injuring the chord above the origins of the phrenic and intercostal nerves. The vertebral arteries at the same time undergo so much stretching, that the blood cannot move through them with the natural facility.

It is nevertheless probable that displacement rarely occurs without such injury to the ligaments as to allow more extensive luxation than that now noticed. The odontoid ligaments, or the transverse, may be ruptured; and in either case the odontoid process is allowed to slip backwards, and plunges into the chord, and destroys its texture almost instantly. These ligaments may be ruptured either immediately by sudden violence, or in consequence of previous disease. In such circumstances, the injury done to the spinal chord is followed by almost immediate death, in consequence of the influence of the phrenic and intercostal nerves being suddenly suspended. In the same manner, the insertion of a cutting instrument between the occipital bone and *atlas*, or between the latter and the *axis*, so as to divide partially or completely the spinal chord above the origin of these nerves, an operation known by the name of *pithing*, is followed by immediate death.

§ 2. *The Chest.* (*Pectus*, Στηθος, *Thorax*.)

The chest may be defined as an osteo-cartilaginous inclosure, of an irregular conoidal shape, flattened before, concave behind, and convex on the sides. Its upper extremity is truncated. Its basis is irregularly oblique. It consists of the *sternum* before, the twelve dorsal *vertebræ* behind, twelve ribs on each side, and twelve cartilages connecting the ribs and sternum.

The sternum or breast-bone.

The *sternum* (*sternum*, στερνον, *os pectoris*) is a symmetrical, oblong, flattened bone, broad above, narrow in the middle, broad below, and terminating in a point placed perpendicularly on the anterior of the chest. It presents two surfaces, an anterior and posterior, two extremities, an upper and lower, and two margins. (Plate XXIV. fig. 1.)

The anterior or cutaneous surface, covered by skin, the aponeurosis of the sterno-mastoid and large pectoral muscles, and periosteum, is marked by four transverse ridges at intervals of an inch, indicating the lines at which the separate portions of the bone were united. The posterior, internal, or mediastinal surface, is a little concave, occasionally marked by a longitudinal depression in its middle; also presents transverse lines, but rather indistinct; is covered in the middle by the mediastinal cellular tissue, above by the sterno-hyoid and sterno-thyroid muscles, and on the sides by the *triangulares sterni*.

The superior or clavicular extremity of the sternum presents three crescentic sinuosities; one on the middle, bounded on each side by an elevated peak, hollowed before and behind, and one on each side, incrusted with cartilage and synovial membrane. The first of these corresponds with the trachea on the inside, and has the sterno-mastoid muscle inserted on each outside. With the two lateral cartilaginous surfaces the sternal extremities of the clavicles are articulated. Between the two is the interclavicular ligament, and all round are the ligamentous fibres of the sterno-clavicular articulation. This upper extremity is about double the breadth of the bone at its middle. Below, the bone becomes narrow, and below the fourth ridge it seldom exceeds half an inch in breadth. Here it terminates in an appendage, which is generally named the pointed or ensiform cartilage (*cartilago mucronata, c. ensiformis*). The shape of this is by no means always the same. In some subjects it is a flat, thin, and pointed process, not always very firm, but more solid than cartilage; in others it is a flat thin bone, terminating in two thin hooked points. In some it is obtuse and perforated. In some it is thrust forwards, in others it is bent inwards, or towards the one side. To this process the aponeuroses of the *recti abdominis* are attached.

The margins of the sternum, which are generally about half an inch thick, present seven articular depressions crusted by cartilage. The first of these, in which the sternal extremity of the first rib is lodged, is, immediately below the clavicular depression, superficial and rounded. The others, which are situate at the ends of the transverse ridges, and receive the cartilages of the next six ribs, are deeper, angular, and surrounded by elevated margins, to which, in the recent state, the circumference of a capsular ligament is attached. In general, the seventh depression is formed partly on the sternum, partly on the ensiform cartilage; and the intervals between the depressions are smaller below than above.

The sternum is chiefly cancellated, light, and loose, with little density, and a thin crust of compact bone. In the fœtus and infant it consists of eight or nine square pieces, separated by transverse furrows, which, by the union of two, are easily reduced to seven, and afterwards to five. By the further union of two of these portions they are afterwards reduced to three; and in this state they remain so long in some subjects that Soemmering describes the sternum not as one bone, but as three. The first of these portions, which is uppermost, is irregularly heart-shaped, or rather octagonal, with the tracheal depression and the clavicular articulations above, the depression for the cartilage of the first rib on the side, and half of that for the second at its lower margin, where it unites with the second. The latter is merely the middle and longest portion of the bone, and is occasionally in three portions, separated at the costal depressions. The third or lower portion is the ensiform cartilage, the ossification of which renders the bone complete.

The ribs.

The ribs may be defined to be long, flat, irregular bones, with an irregular semicircular curvature, placed on each side of the chest, at intervals of an inch or less, between the dorsal vertebræ and the sternum. In general their number is twelve on each side, rarely eleven or thirteen. Of these, seven are connected with the sternum before by individual cartilages, and five are connected indirectly to the cartilage of the seventh, without attachment to the sternum. The former are denominated true or sterno-vertebral ribs (*costæ veræ*); the latter are styled false or vertebral (*costæ spuriæ, vel nothæ*).

Each rib varies in length, breadth, and the direction of its curvature. The upper ribs are the shortest, and most incurvated in proportion to their length. The middle ribs, or the fourth, fifth, sixth, and seventh, are the longest, and form curves of the largest circle. The false ribs, which diminish in length from the eighth to the twelfth, are the least incurvated, or form curves of the largest circle. It is chiefly from the middle set that the common characters of these bones should be derived.

Proceeding on this principle, we find that each rib may be defined as a broad, flat, longitudinal bone, not only in-

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curvated, but twisted from the direction of its original curvature. Each rib has a vertebral extremity, a cartilaginous extremity, and a body. The vertebral extremity consists of a tuberculated angular head (*caput*), with two cartilaginous facettes united at an angular line for insertion in the intervertebral depressions with which they are articulated. In the first and twelfth, and sometimes in the eleventh, there is one facette only corresponding to the single vertebra with which these bones are connected. Immediately before the head the rib is contracted and rounded, so as to form a neck (*collum*), which varies from five to six or seven lines in length; and before the neck is a tubercle or process (*tuberculum*) divided into two portions, one internal, smooth, cartilaginous, and uneven, articulated with the transverse processes of the dorsal vertebræ; the other external, rough, giving attachment to the middle costo-transverse ligament. Anterior to the tubercle the rib is straight for about one inch, and rough by the insertion of the *sacrolumbalis* and *longissimus dorsi* muscles. Beyond this point, which is therefore named the angle (*angulus*), the rib begins to be incurvated circularly, and bent downwards, so that the surfaces, which were external and internal, become obliquely superior and inferior. To prevent confusion, however, they must still be distinguished in the same manner.

The outer surface of the rib, therefore, is convex, and forms the outer bend of the circle. Behind, it is covered by the *latissimus dorsi* muscle. The internal, which forms the inner bend of the circle, is convex above, and forms a concave hollow below, bounded by two sharp margins; one proceeding straight from the head forwards, till it is lost about three inches from the cartilaginous extremity; the other, more acute, from the tubercle, and following the curvature of the rib to about two inches from the same point. In this groove are lodged the intercostal artery, vein, and nerve. The internal intercostals are attached to the inner lip of the margin; the external to the outer. The upper margin of the rib is obtuse behind, where the external intercostals are inserted; but becomes acute and rough before, where the internal intercostals are inserted. The anterior or sternal extremity of the rib is broad and large, and terminates in an oval hollow, in which the cartilage is inserted. In advanced life, when the union between the rib and cartilage is intimate, this hollow becomes less distinct.

Besides these common characters of the ribs, several present peculiarities deserving notice.

The first rib is short, almost semicircular, and its direction is such that its broad surfaces are superior and inferior, not external and internal, as in the others. The head of this rib possesses only one large articular facette, corresponding with the first dorsal vertebra, sometimes one large one, and a minute one corresponding with a small space of the last cervical vertebra. Its neck is short and round, and its tubercle is identified with the angle which is wanting. The superior surface of this rib is highly important. From the head and tubercle extends a rough surface, in which are inserted part of the *scalenus posticus*, part of the *serratus magnus*, and the *scalenus medius*. Next to this is a smooth, deep depression, over which the subclavian artery passes; then is an eminence, to which the *scalenus anticus* is attached; afterwards a superficial hollow, in which the subclavian vein is lodged; and, lastly, a rough surface at the sternal or anterior end, for the subclavian muscle. The lower surface of the first rib is uneven and slightly rough, but without groove at its outer margin.

The second rib resembles the first in direction, having rather an upper and lower, than an external and internal surface. The head is angular and acuminated, and the neck contracted; and the upper surface is rough by the *serratus magnus*; but the lower surface, from the tubercle, begins to present an angle in the shape of an oblique surface, bounded below by a rough ridge, within which is the groove for the intercostal vessels and nerves. Anterior to this flat oblique surface the rib is twisted, and undergoes a change in direction. In the third the angle is not more distinct, and it is only in the fourth that this part is well marked. This character continues to the eleventh, when it becomes indistinct, and in which the tuberosity disappears, or at least is identified with the head, which has only one facette. The groove also is so short as scarcely to be observed. Lastly, the twelfth rib, which is often unconnected with the others by cartilage, is without tuberosity, groove, or angle, and has, like the first, only one facette at the head.

The costal cartilages.

The true ribs are connected to the sternum by means of broad rounded pieces of cartilage, variable in length and direction in different ribs. That of the first rib is very short, rather broad, and its direction, though oblique from above downwards, is more horizontal than that of the inferior ones. The angle at which it unites with the sternum is acute above, and obtuse below. It is often ossified in the adult. The second is nearly horizontal, and follows the direction of the rib to which it is attached. The next five are more oblique from above downwards, as the lower end of the sternum inclines forwards, and the corresponding ribs bulge towards the base of the chest.

Each of these cartilages, invested by perichondrium, is attached by a rough surface to the anterior end of the rib; while the other extremity, which is rounded and covered by synovial membrane, is lodged in one of the articular depressions of the lateral margin of the sternum, and secured in this situation by a capsular ligament, strengthened by anterior and posterior fibrous bands.

The anterior or outer surface of the thoracic cartilages is slightly convex, the internal or posterior surface flat, inclining to concave, lined by pleura and covered by the *triangularis sterni* muscle. The upper margin is concave, the lower convex, giving attachment to the internal intercostal muscles, which in this region fill the intercartilaginous spaces.

The cartilages of the five false ribs differ from those of the true, in not being articulated directly with the sternum. The cartilage of the eighth rib, after bending forwards and upwards, is attached to the seventh by a tapering point with a minute articular surface. The ninth cartilage is attached in a similar manner to the eighth, the tenth to the ninth, the eleventh to the tenth, and the twelfth is either attached in the same manner to the eleventh, or hangs free, though attached to muscles connected with the others. Hence the twelfth, and not unfrequently the eleventh, are denominated floating ribs. The whole of them are mutually connected by ligamentous fibres inserted into their perichondrial covering. The outer surface of these cartilages is covered by the *recti* and external oblique, the inner surface by the diaphragm and *transversus*.

Connected with the ribs in the same manner in which those of the true ribs are, these cartilages differ, however, in taking a direction, first of descent, then of ascent or of curvature. The spaces which they leave between them, instead of being rhomboidal, as those of the true ribs, are irregularly triangular.

In structure the costal cartilages belong to those of the cavities. Analogous to those of the larynx, they are dense, firm, elastic, whitish substances, without distinct traces of organization, and seem to consist chiefly of modified gelatine, to which they are with difficulty reduced by

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long boiling. Their tendency to ossification is considerable. In few persons above 45 or 50 are they quite free from bony points; and in many they are at this period converted into firm bone. The cartilage of the first rib, especially, is often firmly ossified before 35. When they undergo this change, certain points in their substance are observed to assume an orange or tawny colour, and to exhibit a porous arrangement, with great hardness, turning the edge of the knife.

By long maceration the costal cartilages become soft and gelatinous, and are finally resolved into oval patches, separated by circular or spiral lines, with numerous perforations. It was perhaps on this account that Herissant described them as consisting of spiral fibres.

The chest in general.

The bones and cartilages now described, with the twelve dorsal vertebræ behind, constitute the bony skeleton of the chest, bearing a remote resemblance to a cone, with truncated apex and oblique base, or, more accurately, to the frustum of a cone. To form a just idea of this assemblage of parts, it is necessary to consider its surface external and internal, its circumference above and below, its transverse diameter, and its longitudinal extent.

The anterior region of the external surface, consisting of the sternum in the middle, and the cartilages on each side, is flattened, contracted above, wider and more prominent below. The intercostal spaces are filled between the sternum and the ribs by the internal intercostals, behind this by the external and internal, and covered by the anterior part of the large pectoral muscle. Behind, the chest presents the vertebræ with their processes, the transverse processes articulated with the tubercles, the angles forming a line obliquely receding from the spine, the transverse grooves, the longitudinal groove on each side filled by the *multifidus spinæ*, and the space between the processes and the angles of the ribs occupied by the *spinalis dorsi*, the *longissimus dorsi*, and the *sacrolumbalis*. The intercostal spaces, from the spine to the angles, are filled by the external intercostals; and anterior to this are the two layers of muscles.

The lateral regions of the chest are convex, making a larger sweep below than above. They present on each side eleven intercostal spaces, the superior of which are shorter and broader than the inferior. These spaces, which follow the curved direction of the ribs, cannot be accurately defined in shape. Between the angles and the cartilages, where the curvature is greatest, they are occupied by the double layer of the external and internal intercostal muscles, which, lying inclined in opposite directions, mutually decussate in this tract. The lateral region of the chest is covered above by the *serratus magnus* behind, and the two pectorals before; below by the external oblique on the side, and the *recti* before. The inferior lateral region, which is formed by the cartilages of the ribs, is therefore named the hypochondres (*hypochondria*).

The inner surface of the chest is, before, correspondent to the outer surface, unless below, where the anterior inclination of the sternum makes the antero-posterior diameter greater. The posterior region is marked by the row of vertebral bodies, the prominence of which forms an imperfect partition, which separates the right and left halves of the thorax; and which, notwithstanding the posterior bend which the spine undergoes between the second and eighth vertebræ, diminishes the antero-posterior diameter of the chest. On each side is a large concave hollow, narrow above, wide below, and swelling most capaciously in the middle, the walls of which, formed by the ribs and intercostal muscles, are lined by the pleura, and the cavity of which contains the lungs.

The upper circumference of the chest, or its apex, is small, oval, transversely oblique from above downwards, and from behind forwards. Bounded before by the sternum, behind by the first dorsal vertebra, and on the side by the first rib, it is diminished by the clavicles; and while its antero-posterior diameter is occupied by the windpipe, œsophagus, and the large vessels connected with the heart, its lateral portions are so much contracted, that each thoracic half (*demithorax*) has here almost a conical termination. Its dimensions in the male skeleton of average size are about 16 inches. As the first rib has little or no motion, the upper circumference remains unchanged.

The lower circumference of the chest, which is much more extensive, is said to be nearly four times larger than the upper. This, however, is exaggerated; and I find its greatest dimensions in the male to be 32 inches, exactly double the small circumference. It is susceptible of enlargement from the revolving motion of the ribs. The first rib remains fixed, while the lower ones are capable of being rolled outwards on their heads, tubercles and cartilages, so that the transverse diameter of the chest is enlarged. The lower circumference of the chest presents anteriorly a large triangular notch (*incisura trigona*), with the apex at the ensiform cartilage, the sides at the margins of the cartilage, and the base represented by a transverse line uniting the tips of the twelfth rib on each side. This notch, which, in the recent state, is occupied by the heads of the *recti* muscles, with their fasciæ in the middle, and the anterior margins of the external oblique at the sides, constitutes what is called the pit of the stomach (*scrobiculus cordis*), or the epigastric region (*epigastrium*).

The transverse diameter of the chest is small above, but gradually enlarges to the ninth or tenth rib. The average diameter measured between the inner margins of the first ribs on each side in the male skeleton is four and a half inches; the average diameter measured between the tips of the eleventh rib on each side is nine inches, which is also nearly the diameter between the inner margins of the fifth ribs; and the average diameter measured across the upper margin of the ninth rib, which is about the widest part, amounts to eleven inches. These diameters, it has been already said, are susceptible of slight enlargement, by reason of the lateral revolution of the ribs; and this motion is most extensive between the sixth and tenth ribs. Above the sixth and below the tenth it is trifling.

The longitudinal extent or altitude of the chest varies, but in the same male skeleton it amounts to twelve inches measured between the lower margin of the first rib and the upper margin of the eleventh, which may be regarded as the inferior limit of the osseous part of the chest. From the top of the sternum to the plane of the ensiform cartilage the distance is five inches and a half. If from the lower margin of a mesial plane representing the *mediastinum*, another plane be drawn on each side to the margins of the false ribs, the space inclosed on each side above this oblique plane will give some idea of the capacity of the thoracic cavities.

The dimensions above stated apply chiefly to the adult male, from about thirty to thirty-five years, and of average size. In the female the chest is generally smaller in every direction, rounder, and more taper towards its inferior region. Above, as far as to the fourth rib, it is said to be larger and more uneven before, so that it has less of the conoidal shape than the male chest. It is also shorter.

The pectoral cavity is in general symmetrical, that is.

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of similar shape and dimensions on each side of the mesial plane. Sometimes, however, without the intervention of disease, the greater convexity of two or three ribs on one side gives it a more ample appearance than on the other.

§ 3. *The Pelvis.*

This is the name given to the irregular-shaped bony cincture which terminates the lower extremity of the trunk, and which is connected to the spinal column by means of the sacrum. It consists in the adult of four bones, two lateral portions (*ossa coxarum*), and two on the mesial plane, the *sacrum* and *os coccygis*. The latter two have been already described. The lateral and anterior divisions now come under examination.

These consist of two bones, one on each side, united with each other before by means of fibro-cartilage, and receiving between them behind, the sacrum, to which they are in like manner united by fibro-cartilage. These bones, which are denominated *ossa innominata*, coxal or haunch-bones (*ossa coxarum*), are of a very irregular shape, and may be divided into three regions, the superior or iliac, the anterior or pubal, and the inferior or ischial. These regions it is not easy to define accurately; but they will appear in the course of description, and they correspond to the original divisions of the bone in the fœtal state.

The coxal bones.

The coxal bone presents two surfaces, an external or femoral, and an internal or pelvic; and a circumference, divided into superior margin, anterior margin, inferior margin, and posterior margin.

The external or femoral surface (*dorsum*), which is alternately concave and convex, presents behind a rough surface, to which the *glutæus maximus* is attached; between this and a semicircular rough line a lunated hollow, in which the origin of the *glutæus medius* is lodged; and between the upper semicircular line and the lower a convex and concave area, for the attachment of the *glutæus minimus*, and one or two inequalities, to which one of the tendons of the *rectus femoris* is attached. About an inch below is a large hemi-spherical cavity, with elevated circular margins, interrupted at the anterior and inferior corner, named the *acetabulum*, or cotyloid cavity, for receiving the head of the thigh-bone. Its inner surface is covered by cartilage, unless at the centre, where is a depression for the attachment of the triangular ligament of the thigh-bone. The lower part of the margin is marked by a deep notch, over which, in the recent state, is stretched a ligament, thus forming a hole for the transit of the vessels and nerves of the articular cavity. The surface behind the acetabulum is slightly convex, indicating its union with the upper edge of a part of the coxal bone, distinguished by the name of hip-bone (*os ischii*), and may be denominated the *post-acetabular* or *ilio-ischial eminence*; below, it is concave and sinuous, for the tendon of the *obturator externus*, and terminating in a sharp spine (*spina ischii*), to which the small sacro-sciatic ligament is attached. Anterior to the acetabulum is a large opening, named the *thyroid* or *obturator* hole, oval in the male, and triangular in the female, closed by a ligament attached to its circumference, unless at the upper part, where there is an oblique groove for the *obturator* vessels and nerve. The outer surface of the thyroid ligament supports the *obturator externus* muscle, the inner surface the *obturator internus*. The upper margin of the thyroid hole is overhung by a convex ridge of bone, which is named the pubal or the horizontal branch of the pubal bone (*os pubis, pecten, os pectinis*) from supporting the parts of generation, and which terminates at its inner or mesial margin in a spine or tubercle, to which the outer portion of the tendon of the external oblique muscle is attached. The inner or anterior margin of the thyroid hole is bounded by a broad flat bone, irregularly rough on the surface, broad above, where it is connected with the *os pubis*, narrow at the middle and lower part, where it joins the ischial bone. To the upper part of this, which is named the descending branch (*ramus*) of the pubis are fixed the *gracilis*, the head of the *adductores longus et brevis*, part of the *adductor magnus*, and part of the *obturator externus*. The lower part, which is named the ascending branch (*ramus*) of the *ischium*, gives origin to the *adductor magnus*.

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The coxal bones.

The inner or pelvic surface (*venter*) of the coxal bone may be divided into three parts. The first is posterior, rough, and irregular, for articulation by fibro-cartilage with the lateral margin of the sacrum. The second, which is abdominal, concave, and is named the iliac pit (*fossa iliaca*), contains the belly of the *iliacus internus*, bounded above by the circumference or crest of the bone; behind by a rough line which separates it from the sacral surface; before by a concave irregular bend formed above by the iliac, below by the pubal bone; and below by a sharp line (*linea ilio-pectinea*), which is insensibly lost on the spine of the pubis, and to the inner end of which is attached a reflected portion of Poupart's ligament, named the *ligament of Gimbernat*. The third or pelvic surface, which is below, presents behind a flat, irregular-shaped, concave space, occupied by the *levator ani* and part of the *obturator internus*, the inner opening of the thyroid hole, the inner surface of the *rami* of the pubal and ischial bones, with inequalities for the origin of the *obturator internus*, and a sinuosity below the ischial spine for the motion of its tendon.

The circumference of the coxal bone is very irregular. The upper or iliac portion, which is semicircular, and is named the crest (*crista ilium ossis*), is rough for muscular and tendinous attachments, varying in breadth from half an inch to a whole one, and is distinguished into an external and internal lip, and an intermediate space. To the former are attached the external oblique, the *latissimus dorsi*, and the *tensor vaginæ femoris*; to the latter are attached the *transversus* and the *quadratus lumborum*; and in the middle space between the two is the internal oblique. The posterior end of the crest terminates in the posterior superior spinous process, to which part of the *glutæus maximus* and the ilio-lumbar ligament are attached, and below the posterior inferior spinous process forming the upper extremity of the ischiatic notch. The crest terminates before in the anterior superior spinous process, to which are attached the *fascia lata*, the *sartorius*, and the upper end of the tendon of the external oblique, or ligament of Poupart, or what is named the crural arch. The anterior portion presents, first a small sinuosity, which separates the superior from the inferior spinous process, to which is attached the upper tendon of the *rectus cruris*. Between this and an eminence in the upper or horizontal portion of the *os pubis*, marking its junction with the iliac bone, and which may be denominated the *ilio-pubal*, is a large sinuosity, in which are lodged the tapering ends of the *iliacus internus* and *psoas magnus*. To the ilio-pubal eminence the *psoas parvus* is attached; and within the pubal eminence, and anterior to the *linea ilio-pectinea*, is a triangular space, to which the origin of the *pectineus* is fixed. This part of the circumference is terminated by the spine of the pubal bone, to which the first insertion of Poupart's ligament, or the outer pillar of the inguinal ring, is fixed. On the mesial side of this is a rough tubercular surface, which by means of fibro-cartilage is united with a similar surface on the opposite side. To this, which is named the *symphysis pubis*, the second insertion of the ligament of Poupart, the *pyramidales* and the *recti*, are fixed.

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The coxal bones.

The posterior-inferior margin is most irregular. Commencing with the posterior spinous processes, which are parted by a small notch, the margin is, immediately anterior to the lower process, formed into a large hollow, named the ischiadic notch (*incisura ischii*), bounded before by the spine of the ischium, to which is attached the anterior sacro-ischiadic ligament, with the superior head of the *gemellus* without, and the *coccygeus* within. A pretty large hollow, in which play the belly and tendon of the *obturator externus*, separates the spine from the tuberosity of the ischium, a large broad rough surface, the external surface of which gives support to the *quadratus* and *adductor magnus*, the inner surface to the lower head of the *gemellus* and the external or inferior sacro-ischiadic ligament, while in the middle are fixed the long head of the *biceps flexor*, the *semitendinosus*, and the *semimembranosus*. From the tuberosity the margin of the bone along the ascending branch of the ischium, and the descending branch of the pubis, becomes narrow till it reaches the *symphysis*, when it again becomes broad and more irregular. To the former margin are attached the *gracilis*, the *transversus perinæi*, the *erector*, and the *corpus cavernosum*. The latter uniting with the opposite bone by means of the interpubal fibro-cartilage, constitutes the *symphysis pubis*.

Structure.

The iliac or coxal bones consist of cancellated matter, covered by a thin layer of compact bone. In early life, and in delicate subjects, this cellular matter is loose, abundant, and rather thick. At a more advanced period, when ossification is completed, and in strong muscular subjects, the proportion of this cancellated matter diminishes and sometimes disappears, so that the bone consists of two layers of dense, compact bone; and in some, even this, in the iliac fossa, is destroyed entirely, so that the bone appears perforated.

Developement.

The coxal bone is formed originally of three pieces, one for the large upper portion (*os ilium*), a second for the anterior or pubal (*os pubis*), and a third for the inferior or ischial (*os ischium*). In the fœtus, infant, and young subject, these three bones are seen quite distinctly separate, but adhering, by means of fibrous or fibro-cartilaginous tissue, along a line drawn by the ilio-pubal eminence through the acetabulum, and over its posterior convexity into the ischial notch. At the same time the crest and margins of the ilium are covered by a cartilaginous epiphysis; the pubal bones are mutually attached by the same substance; the branches (*rami*) of the pubal and ischial bones are soft and membranous; the thyroid hole is merely a ligamentous notch; and the acetabulum is a broad, irregular, superficial depression, with fibro-cartilaginous margin. The connections of these three bones continue soft and cartilaginous for several years after birth, generally to the tenth, twelfth, or fourteenth, sometimes later; and this is the reason why the *os innominatum* has been described as consisting of three bones, the *os ilium*, *os pubis*, and *ischium*. After the last-mentioned period, however, these bones are firmly consolidated into one piece, in which, nevertheless, the original marks of separation may be recognised in the ilio-pubal and post-acetabular eminences above, and the meeting of the pubal and ischial *rami* below. The coxal bone, therefore, which thus becomes a single solid piece in the adult, ought to be always described as such; and the distinction into three component parts, which is confined to the fœtal and early period of life, belongs to the history of its ossification.

The coxal bone is united to its fellow of the opposite side by the *symphysis pubis*, and behind to the sacrum by the sacro-iliac fibro-cartilage (*synchondrosis*). Both of these junctions are occasionally ossified in advanced life. By the cotyloid cavity it is articulated with the head of the thigh-bone.

The pelvis generally and its dimensions.

The coxal bones on each side, with the sacrum wedged between them behind, and the os coccygis attached to its extremity, constitute an irregular-shaped osseous cincture, something conical, with the base above, and the truncated apex below. This shape, with the manner in which it supports the abdominal viscera and several of the urinary and genital organs, has given it the name of basin (*le bassin*, *das becken*, *pelvis*) or pelvis. In this it is requisite to consider the external and internal surface, the upper and lower circumference, the transverse diameters, the direction, the outlets and their dimensions.

The external surface comprehends four regions, the anterior or pubal, the posterior or sacral, and two lateral.

The anterior region presents the pubal articulation (*symphysis*) on the median line, and on each side the pubo-ischial *rami*, the thyroid hole and its margins, and the *acetabulum* or articular cavity. The posterior region presents on the median line the sacral spinous processes or spinous ridge, the triangular depression which terminates the spinal canal, the suture uniting the sacrum to the coccyx and the posterior convex surface of the latter; and on each side are the sacral grooves and posterior holes; the processes by which they are bounded without; a deep depression corresponding to the sacro-iliac *synchondrosis*, and which is filled by a thick bundle of ligamentous fibres; and lastly, the posterior tuberosity of the ilium, which projects much behind. The lateral regions are formed by the *dorsa* or external *fossæ* of the iliac bones, bounded below by the ischiadic notches.

The internal surface of the pelvis consists of two portions,—the one above, wide, capacious, and tapering downwards, forming the large pelvis; the other narrower, with walls nearly cylindrical, and forming a canal named the small pelvis.

The large pelvis presents, behind, the sacro-vertebral articulation and the sacral promontory, and on the sides the internal iliac *fossæ*. Before, where osseous parietes are wanting, the space is occupied by the abdominal muscles. This constitutes the abdominal division of the pelvis, and supports in the erect position part of the ileum and colon. Its transverse diameter, measured between the crests of each iliac bone, amounts to nine inches in the male, and eleven in the female.

The large or abdominal division of the pelvis is bounded below by the ilio-pubal line on the sides and front, and behind by a line drawn between the posterior extremities of each side, but following the surface of the sacrum. The outline of this, which is elliptical, with the transverse diameter longest, and its plane inclined obliquely forwards, is named the superior outlet or aperture (*ambitus superior*) of the pelvis, and it constitutes at once the lower termination of the great and the upper boundary of the small pelvis. Its importance in the practice of midwifery renders it necessary to distinguish its calibre, which is larger in the female than in the male, into four diameters. The first, antero-posterior, from the pubal symphysis to the sacral promontory, is from four to five inches in the male, and four inches nine lines in the female. The second, transverse, measured between the iliac bones, is four inches six lines, sometimes five inches, in the male, and five inches six lines in the female. Two others, drawn obliquely from the sacro-iliac synchondrosis to the ileo-pubal eminence, are about four and a half inches in the male, and five inches in the female.

The small or proper pelvis, which is below this aperture, forms a sort of cylindrical osseous canal, more capacious,

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however, at its middle than at the extremities, the lower outlet of which is diminished by the anterior incurvation of the sacrum and coccyx, while the sides are bounded by the ischio-pubal branches. Before are the inner surfaces of the pubal symphysis and branches, corresponding to the urinary bladder; behind, the pelvic surface of the sacrum, corresponding to the rectum; laterally, the thyroid holes, the inner surface of the ischial-bone and ilio-ischial junction, and the ischiatic notch, completed by the anterior and posterior sacro-ischiatic ligaments.

The upper circumference is very irregular, with its plane slightly inclined forwards; larger in the female than in the male. It presents, behind, the sacro-vertebral articulation, bounded by a depression indicating the upper edge of the sacro-iliac synchondrosis; laterally, the two iliac crests terminating before in the anterior superior spinous processes; before, the hollow of the *iliacus internus* and *psoas magnus*, the ilio-pubal eminence, the horizontal branch of the pubal bone, its spine, and lastly its symphysis.

The lower circumference, which corresponds with the inferior aperture or ano-perineal outlet of the pelvis (*ambitus inferior*), is directed downwards and backwards. Bounded behind by the coccygeal bone, and on the sides by the ischial tuberosities, this outlet is thus distinguished for three eminences, separated by an equal number of notches. The situation of these eminences indicates the limits of the lower pelvic aperture. The size and disposition of the notches is inversely to that of the eminences; and their arrangement is such that an eminence is opposite to a notch, and conversely. Thus the anterior notch, which is formed by the pubal arch, is opposite to the sacro-coccygeal eminence behind; and though the ischial tuberosities appear opposite to each other in one sense, strictly speaking their plane is each accurately opposed to the opposite sacro-ischial notch. The anterior notch is terminated above by an acute angle in the male, in consequence of the proximity of the pubo-ischial branches which form its sides, but by a rounded arch in the female, by reason of the separation of these branches on each side. In this notch are situate the generative organs of both sexes. The lateral notches, which are bounded behind by the sacrum and coccyx, before by the spine and tuberosity of the ischium, are irregular in shape, and are each subdivided into three portions by the sacro-sciatic ligaments, which secure the articulation of the sacrum and coxal bones. The first of these ligaments, the posterior or external, arising from the posterior extremity of the iliac crest, from the sides and transverse processes of the sacrum and coccyx by a broad, firm web of fibres, becoming small and thick at the middle, again expands, and is inserted into the ischial tuberosity. This ligament corresponds behind to the *glutæus maximus*, which is partly attached to it, before and mesially to the small or anterior ligament to which it is united. The small or anterior sacro-sciatic ligament rises, in common with the large one, from the transverse processes of the sacrum and coccyx, and adhering to it for half an inch, passes more horizontally outwards to the ischial spine, in which it is implanted by a broad, thick, fibrous web. Behind, it corresponds at its sacral end, and for an inch from this to the posterior ligament, and laterally to the pudic vessels and nerve; before, it serves with the posterior to complete the lower circumference of the pelvis.

By these two ligaments the ischiadic notch is in this manner converted into two apertures and a notch. The first of these is superior, and is bounded above by the ilio-ischial arch, and below by the small ligament and part of the posterior or large ligament. Through this hole pass the *pyriformis*, the sciatic nerve and artery, the gluteal artery, and the internal pudic artery. The second is an irregular triangular hole, smaller than the upper one, bounded above by the anterior ligament, below by the posterior one, and laterally by the sinuous hollow between the ischial spine and tuberosity. Through this aperture the tendon of the *obturator internus* passes out of the pelvis; and the external pudic artery and nerve, after bending round the upper ligament, re-enter the pelvis. The third space is a superficial notch, bounded on the outer or lateral side by the posterior ligament, and on the mesial side by the sacro-coccygeal bone. It is chiefly occupied by cellular tissue.

The dimensions of this inferior aperture are nearly the following. The antero-posterior diameter, from the coccygeal apex to the lower margin of the pubal symphysis, is 3 inches in the male, and 4 inches 6 lines in the female. The transverse diameter between the ischial tuberosities of each side is 3 inches 2 lines in the male, and 4 inches in the female. The oblique diameter, measured from the middle of one of the great sacro-sciatic ligaments to the opposite ischial tuberosity, is about 4 inches in the male, and from $4\frac{1}{2}$ to 5 in the female. Of these diameters the antero-posterior is most liable to vary, by reason of the mobility of the os coccygis; but independent of this, it is always larger in the female than in the male, in consequence of the sacrum being less incurvated, and descending more in a straight line. It further appears, that in females who have born children the incurvation of the sacrum is much less than in those who have not.

The direction of the pelvis is not horizontal, nor does it correspond with that of the trunk. Articulated behind with the lumbar portion of the spinal column, the axis of which is inclined considerably forward from the vertical plane, the pelvis partakes of the same inclination. A horizontal line drawn from the pubis towards the sacrum passes in general an inch below the tip of the coccyx; and with this a line drawn from the pelvis to the upper margin of the sacrum, representing the plane of the pelvis, makes an angle of between 80° and 85°. The sacrum inclines from the vertical plane about 35°; but the inclination of the superior and inferior pelvic apertures varies. An imaginary line drawn from the tip of the coccyx to the centre of the small pelvis, to represent the axis, cuts the line of inclination at an angle of 75°. The most accurate axis of the pelvis is a line drawn at right angles to the plane of the pelvis as above found.

The dimensions given above are sufficient to show that the female pelvis is much more capacious and ample laterally than the male. In the female, indeed, it is important to remark that the upper region of the coxal bones is more prominent laterally, and hence renders the haunches prominent and rounded, and the outline of the abdominal aperture more extensive; the sacro-vertebral angle is less prominent, and the sacrum is broader and less incurvated; the arch of the pubis is wider and less angular; the ischial tuberosities are more apart, and the cotyloid cavities even are at more distance from each other,—a circumstance which determines the peculiar gait of the female. The male pelvis, on the contrary, is deeper than the female.

In the infant the pelvis is small compared with the size of other bones, and of the parts which it is to contain. The dimensions of this part, in early life, are indeed so limited, that not even the urinary bladder can be said to be contained within it. As puberty approaches, the distinctive characters of the male and female pelvis begin to appear. While in both sexes the bones become larger and the cavity more capacious, in the female the addi-

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tional amplitude appears in the width of the haunches, and their remarkable projection beyond the flanks.

The Head.

The upper or atlantal extremity of the vertebral column supports the head, a complicated assemblage of bones, the general shape of which is spheroidal above and behind, and irregularly cubical before and below. It is naturally divided into two parts, which are distinguished by their mechanism, their use, and the mode of their developement. The first of these, the scull or cranium (*κρανιον, calvaria*), forms a spheroidal bony case, occupying the superior and posterior region chiefly of the head. The second, which is the face, is formed above by an irregular pile of bones, articulated immovably to the anterior inferior part of the scull, and below by a single symmetrical bone, articulated movably to the middle of the lower part of the scull.

§ 4. *The Scull.* (*Cranium, Calvaria.*)

The scull.

The scull consists of eight bones, four of which are symmetrical and arranged on the mesial plane, and four arranged in pairs on each side. The four symmetrical bones are the frontal, the ethmoid, the sphenoid, and the occipital; the four lateral are the two parietal and two temporal bones.

The frontal bone.

The frontal bone (*os frontis, os coronæ, sinciput*) is a symmetrical bone occupying the anterior part of the scull, and forming the anterior part of the scalp and the part of the face distinguished as the brow (*frons*). It may be divided into three surfaces, the external or frontal, the inferior or orbito-ethmoidal, and the internal or the cerebral, and a circumference. The external surface is frontal and temporal.

The frontal surface, which is convex and regularly arched, presents on the median line a ridge, indicating the original separation of the bone in two halves, the nasal protuberance, more convex in age than in youth; and corresponding to the smooth interval between the eyebrows (*glabella*), a serrated margin articulated in the middle with the nasal bones, on the sides with the ascending processes of the superior maxillary bones, and, lastly, the nasal spine, which supports the nasal bones. (Plate XXV. fig. 2. n.)

On each side of the median line are the large smooth surface of the upper part of the frontal bone, the frontal protuberances (*tubera frontis*), large in youth, small in advanced age; the superciliary arch (*supercilium*), an irregular convexity extending transversely about an inch on each side of the mesial line, most prominent within, where the *corrugator supercilii* is fixed; and, lastly, the orbitar arch, large and prominent at its temporal angle, smaller and more rounded at its nasal, and presenting either a hole, or a notch covered by a ligament (c. c.), and through which pass the frontal artery and nerve. The nasal end of the orbitar arch, sometimes named the *internal angular process*, is insensibly lost in the serrated surface, where it joins the superior maxillary bone. The temporal process, which is prominent, terminates in a serrated surface, which is articulated with the malar bone. Exterior to the frontal protuberance is a curvilinear ridge (d.), which gives attachment to the fascia of the temporal muscle, denotes the anterior boundary of the space in which that muscle is lodged, and separates the proper frontal from the temporal surface of the frontal bone. This ridge, descending in a circular direction, terminates in the temporal process at the opposite side to that of the orbital arch (a. a.) The triangular segment cut off by it is convex above and concave below.

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The orbito-ethmoid surface is irregular. It presents first on the median line a quadrilateral notch with serrated margins, in which the ethmoid bone is articulated. These margins consist in adult subjects of two plates, between which are seen segments of the frontal and ethmoidal sinuses. In the outer of these tables are generally one or two holes, or notches, which, with the ethmoid bone, form holes (*foramen orbitarium internum anterius et posterius*). Through the former pass the ethmoidal twig of the nasal branch of the ophthalmic nerve; through the latter the posterior ethmoidal artery and vein. On each side of the ethmoidal groove is a triangular concave surface, which forms the vault of the orbit, near the outer margin of which, and within the external angular process, is a superficial pit for the lacrymal gland, and towards the nasal side a depression for the reflected tendon of the superior oblique muscle.

The internal or cerebral surface, which is concave, covered by the *dura mater*, presents on the median line a groove, the beginning of the sagittal, in which the superior longitudinal sinus is lodged, and the margins of which, converging below, form a crest corresponding to the upper margin of the falx. Below this is the *foramen cæcum*, which in the bone communicates with the two canals belonging to the nasal bones, but in the recent state allows some veins to pass from the nose to the longitudinal sinus. It is sometimes common to the frontal and ethmoid bones. (Plate XXV. fig. 3. c.)

On each side the frontal bone presents the large cavities, in which are contained the anterior extremities of the hemispheres of the brain; and above these the bones rise in the manner of a vaulted arch. The whole inner surface is moulded into alternate pits and eminences, called *digital* and *mammillary* respectively, and which correspond to the eminences and depressions of the cerebral convolutions. These are most conspicuous at the lower part, where the surface is traversed by minute vascular grooves.

The circumference of the bone is serrated all round, for articulation with the contiguous bones. The posterior margin is nearly of an elliptical outline, straight, and interrupted below by the quadrilateral notch. Above, where the frontal is articulated with the parietal bones, the serrated processes proceeding from the outer table are largest and longest. Below, where the frontal is articulated with the lower angle of the parietal and wing of the sphenoid bone, the internal table is most prominent, so that the spheno-parietal suture is imbricated. Between the temporal and orbitar fossæ this separation of the tables forms a triangular rough surface, which is articulated with a similar one, the triarcual surface of the sphenoid bone; and between this and the quadrilateral notch the margin is articulated in the same manner with the anterior margin of the sphenoid bone. Lastly, the serrated and cellular margins of the quadrilateral notch are connected with the ethmoid bone.

Besides these cranial bones, the frontal is articulated with the following bones of the face,—the nasal bones by the middle of the nasal suture, the superior maxillary bones by its sides, the lacrymal bones by the anterior end of the ethmoidal groove, and with the malar bones by the external angular processes.

The frontal bone, which is thick at the nasal protuberance and the external processes, and thin at the orbitar regions, is ossified by two points, which, appearing at the frontal protuberances, proceed by radiation as from a centre towards the circumference of the bone. In the fœtus and early infancy the bone thus consists of two lateral portions placed between the pericranium and *dura mater*,

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with a longitudinal interval on the mesial plane, a transverse one on the site of the coronal suture, and a triangular chasm at the angle between the two. This chasm, with a similar one between the frontal bones, forms a quadrilateral lozenge-shaped space, at which the motion of the brain is distinctly felt both at birth and for months after, and which is therefore named the *fontanelle*, or the anterior *fontanelle* (*fons pulsatilis; bregma*), or the open of the head. As the ossific process advances, the lateral margins of the bone extend, and the mesial margins extending mutually, at length coalesce, first at the nasal protuberance and along the forehead, afterwards above, until the fontanelle is progressively diminished and at length obliterated. This junction is effected by the formation of serrated processes, which are mutually dove-tailed into each other; and for some years after birth the frontal bone consists of two similar halves articulated by a middle suture. In some few instances, especially in the female, this continues for many years; and the individual is found after death to have the frontal bone in two halves, with a middle suture. More frequently, however, the suture is obliterated by the consolidation of its serrated margins, and the frontal bone consists of one piece. The points of ossification remain long distinct in the form of the frontal protuberances. But eventually, from the uniform elevation of the margins of the bone, they become less conspicuous; and in old age they disappear more or less completely, leaving a surface uniformly uneven.

The ethmoid bone.

The ethmoid or sieve-like bone (*os cribriforme*), which is symmetrical, and occupies the quadrilateral notch of the frontal bone, consists of several bony plates arranged at right angles, and parallel with each other, so as to give the whole a cubical shape. It consists of four parts, a horizontal plate, occupying both sides of the mesial plane; a vertical plate at right angles to it, and corresponding with the mesial plane; and a lateral plate on each side, also vertical and parallel to the middle plate. In the bone thus formed the following circumstances deserve attention. (Fig. 5.)

The superior surface, cerebral, covered by *dura mater*, is formed by the horizontal plate, perforated by numerous holes (*lamina cribrosa*), through which pass the fibrils of the olfacient or first pair of nerves depressed longitudinally on each side, but surmounted in the middle towards its anterior half by a strong process of a triangular shape, named the cock's comb (*crista galli*), and to which is attached the anterior inferior extremity of the falx, or dichotomous membrane. The anterior margin of this process is generally marked by a groove which, with that of the frontal bone, forms a passage for the nasal vein into the longitudinal sinus. The posterior margin of the perforated plate is marked by an angular notch between two horns, for articulation with a salient angle of the sphenoid bone. The *crista galli* may be regarded as the upper division of the vertical plate, which occupies the mesial plane, and which is thick and sometimes bifid before, but thin and rough behind, where it acts as a partition to the lateral halves of the ethmoidal cavities. The sides of this middle vertical plate are furrowed by minute canals (*canaliculi*), traced from the *foramina* above, in which the nervous fibres are lodged. This plate, and indeed the lower surface of the perforated plate, are covered by a fibro-mucous membrane, which has been named the pituitary or the Schneiderian. The vertical ethmoid plate is articulated at its lower margin with the *vomer* and the triangular cartilage of the nose, before with the nasal spine of the frontal bone, and behind with the median crest (*processus azygos*) of the sphenoid bone.

The lateral portions of the ethmoid bone consist externally of a smooth flat bone (*os planum* of the ancients), which forms the inner or nasal wall of the orbit, internally of two bones convoluted on themselves, and which are distinguished as the superior and middle turbinated bones (*conchæ, ossa turbinata superiora et media, ossa spongiosa*). These bones are seen most distinctly behind; but to form a correct notion of their figure, it is requisite to detach the lateral portions and examine them separately, when the following peculiarities may be recognised. The *ossa plana* on each side terminate in concave oblong quadrilateral plates, diverging outwards from the vertical plane. At the internal edge of these quadrilateral plates is seen above a convex bone, with numerous minute perforations, the orifices of short canals. This is the superior turbinated or spongy bone. Below, and a little to the external side, is a small groove, separated by a thin plate from a larger cavity, which is the superior *meatus*, leading into the posterior ethmoid cells. Below this, again, is the osseous plate, with perforated edges turned on itself from within outwards, so that its convex side is towards its fellow, and its concavity is below and laterally, and separated by another thin plate from the lower margin of the *ossa plana*. This is the *middle turbinated bone*, the longitudinal cavity of which communicates with the lower or nasal surface of the bone, and is bounded on its outer margin by the lower margins of the *ossa plana*, where they are articulated with the inner margin of the orbitar plate of the maxillary bone. The anterior deficiency of the *ossa plana* is occupied by the lacrymal bones.

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The ethmoid bone.

The internal surface of these bones generally is covered by a thin fibro-mucous membrane, partaking of the characters of periosteum at its attached, and of mucous membrane at its free surface.

The ethmoid is articulated with the frontal bone, the sphenoid, the superior maxillary bones, the nasal, the lacrymal, the palate bones, the inferior turbinated bones, and the vomer, at the parts already indicated.

In structure the component plates are compact, unless at the *crista galli*, which contains some cancellated tissue, and the middle and superior turbinated bones, which seem less dense than the horizontal plate.

The ethmoid bone consists in the fœtus of loose, soft, brown-coloured substance, contained in a thick vascular membrane, and disposed in the cubical shape, but without the complicated arrangement of convoluted plates by which it is afterwards distinguished. Into this the nervous fibrils penetrate, and are observed to be ramified. This continues at least four or five months after birth, when these fibrils become surrounded with compact bone deposited in their interstices, and in this manner the perforated plate is formed by deposition round the nerves. About the same time, on the mesial plane is observed a vertical plate, which gradually becomes condensed into solid bone, in the shape of the *crista galli* and middle partition. Soon after, as the bone increases in size, excavations are formed, and the soft uniform substance is removed, while plates of thin but solid bone interposed between thick vascular membranes are observed to be formed. The plates, which are slightly convoluted, become thinner and more solid, and are at length moulded into the superior and middle turbinated bones. The ethmoid is generally complete about eighteen months after birth; and about the second year its different component parts may be recognised. The holes of the perforated plate are, however, larger and more numerous at this age than afterwards. The minute grooves (*canaliculi*,) described by Scarpa, in the lateral portions, are also more distinct and larger than subsequently. It ossifies therefore in four points

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one for the horizontal plate, one for the vertical, and one for each lateral mass.

The sphenoid bone.

The sphenoid, wedge-like or cuneiform bone (*os cuneiforme, os sphenoides*, Σφηνοειδὲς)—a symmetrical bone, of a very irregular and complicated shape, wedged as it were between the bones of the scull, may be distinguished into cerebral or superior, and anterior-inferior or external surfaces. By the ancient anatomists it was compared to a bat with the wings expanded, and is by them distinguished into a body and wings, great and small. (Fig. 4.)

The cerebral surface, covered by the dura mater, is superior, and forms part of the internal base of the scull. It may be distinguished into four parts; the middle, the upper anterior, and two lateral. The middle consists of a smooth surface, on which lie the olfacient or first pair; a transverse groove for the commissure of the optic nerves; a transverse eminence named the olivary (*processus olivaris*); a deep quadrilateral pit in which is contained the pituitary gland, named the Turkish saddle (*sella Turcica, ephippium, fossa pituitaria*), with a slight groove on each side for the transit of the sixth pair of nerves, and bounded behind by an elevated eminence, with two processes, named the posterior clinoid or couch-like processes. The sides of the *sella Turcica*, especially before and behind, present generally a pit, in which is lodged part of the carotid artery. The anterior serrated margin of this surface is articulated with the ethmoid bone; the posterior with the cuneiform process of the occipital bone.

The upper anterior portions consist of two triangular spaces, united to the middle by their base. This surface, which corresponds to the anterior lobes, is bounded before by a serrated margin articulated with the frontal bone, behind by a smooth curved margin, which corresponds to the Sylvian fissure, and marks the separation of the anterior and posterior cerebral lobes. This arch, which may be named the *sphenoidal*, terminates before in a sharp process, named the ensiform, articulated with the frontal bone, and behind in a similar though smooth process named the anterior clinoid. Anterior to this, and between it and the olivary process, is the optic hole (*foramen opticum*), for the transmission of the optic nerves on each side. Behind this hole, and on each side of the olivary process, is the groove in which the internal carotid is lodged. The triangular surfaces now described are commonly named the small wings (*alæ minores sive superiores*), or the wings of Ingrassias. (Fig. 4, a, a.)

The lateral surfaces are concave, marked with cerebral depressions and vascular grooves, four-sided, low behind, but rising to an angular peak before, and are commonly named the large wings (*alæ majores, alæ mediæ*, Soemm.) (A, A.) From the small wing of Ingrassias it is separated by a longitudinal fissure, extending obliquely from the sides of the *sella Turcica* upwards and laterally. Through this opening, which is large below and narrow above, and is variously named the superior orbitar fissure, the sphenoidal fissure (*foramen lacerum superius et anterius*, l, l), pass the third pair or oculo-muscular nerves, the fourth or pathetic, the first or ophthalmic branch of the fifth, and the sixth or abductor nerves, the optic vein, and a branch of the lacrymal artery. Behind, and a little to the outside of the sphenoidal fissure, is the round or superior maxillary hole (*foramen rotundum*, r, r), for the transmission of the second or superior maxillary branch of the fifth pair; and still more posterior and laterally the elliptical hole (*foramen ovale*), for the transmission of the third or inferior maxillary branch of the fifth pair. This part of the large wing terminates behind in an angular process named the *spinous*, articulated with the petrous portion of the temporal bone, and in which is seen the spinous hole (*foramen spinosum*), through which a branch of the external carotid, the middle meningeal artery (*arteria duræ matris media, maxima*), enters the cranium to be distributed on the *dura mater*.

The lateral surfaces terminate before in an elevated recurved peak, surmounted by a triangular surface mostly serrated, but smooth behind, articulated with a similar surface of the frontal bone; laterally in a concave serrated margin articulated with the convex serrated margin of the temporal bone; and behind in a smooth margin, which, with a similar one of the pyramidal portion of the temporal bone, forms the anterior fissure of the base of the cranium (*foramen lacerum anterius in basi cranii.*)

The anterior inferior surface presents several distinct regions. On the mesial plane, at right angles to the serrated margin, is a vertical crest or spine, which terminates below in a process denominated therefore the *azygos* or *rostrum*. (*a.*) The upper crest is articulated with the vertical plate of the ethmoid bone, the lower with the fissure of the *vomer*. On each side the bone is convex, from the swelling of the sphenoidal sinuses, into which may be seen a small opening, which, however, is nearly closed by an osseous plate, variable in shape, named by Bertin the sphenoidal turbinated bone. The interior of the sinuses is parted into two halves by a middle plate, corresponding to the external crest. On each side of this middle portion is the outer surface of the small wings, forming part of the orbit penetrated by the optic hole, to the circumference of which are attached the *levator palpebræ superioris* and *levator oculi* above, the *depressor oculi* below, the *adductor* within, the *abductor* without, and the superior oblique (*trochlearis*) between the two last. Between the margins of the small and great wings is the outer orifice of the sphenoidal fissure; and on the other side of this is the orbitar surface, hollow, bounded above by the serrated margin of the triangular area, without by that of the malar process, and below by a smooth ridge, which, with the posterior one of the superior maxillary bone, forms the spheno-maxillary fissure. Immediately between this is the external orifice of the superior maxillary hole. External to the malar serrated edge is the zygomato-temporal surface, hollow, inclosed within three curvilinear serrated margins and two rounded ones, and parted into two portions, the temporal and zygomatic, by an elevated ridge, to which are attached aponeurotic slips of the temporal muscle. Below this transverse crest is a concave surface, lost in the external pterygoid process, and forming part of the zygomatic fossa, terminating, like the similar part of the large wing, in the spinous process, and presenting first the elliptical, and then the spinous hole.

The rest of the outer surface of the sphenoid bone terminates in two prominent bony plates, the one external, thin, and flat, the other internal, thicker, and more pointed, named the pterygoid or wing-like. These processes rise almost at right angles to the plane of the posterior part of the lateral wings by a thick prismatic piece of bone, common at first to both. Soon, however, they become distinct, especially behind. The external plate, which is thin, broad, and sharp, rises from the lateral portion between the round and oval hole, and, with its plane turned obliquely outwards, terminates in an end round below and before, sharp behind. (b, b.) To the outside of this plate, which is irregularly rough, with part of the zygomatic fossa, is attached the external pterygoid muscle. The inside of the external plate is concave, and forms, with the internal, part of the pterygoid *fossa*, in which are lodged the internal pterygoid muscle and the external *peristaphylinus*. The internal pterygoid process, rising on the inside, narrower and more curved, terminates in a bent point named the unciform or hook-like process (c, c), over which in a

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peculiar groove moves the tendon of the external *peristaphylinus*. The base of the external process generally presents a longitudinal superficial depression named the navicular. Between the external and internal is left a triangular space, which is completed by the pyramidal portion of the palate bone. The base of the internal pterygoid process is penetrated by the Vidian canal (*canalis Vidianus*), larger before than behind, through which is reflected the posterior twig of the spheno-palatine ganglion, sometimes named the Vidian nerve (Plate X. fig. 2), to join the sixth at its connection with the great sympathetic, with some blood-vessels.

The posterior part of the body of the sphenoid bone presents a quadrilateral surface of some extent, rough, cartilaginous, and sometimes excavated into small cells, for articulations with the cuneiform or basilar process of the occipital bone. In the young subject this surface is soft and cartilaginous; but as age advances it becomes more solid, and is at length inseparably ossified with the occipital bone. From this circumstance Soemmering describes the sphenoid and occipital as one bone, under the name of spheno-occipital; a method in which he has been followed by Meckel. The bone, however, is so complicated in shape and the arrangement of its parts, that it is perhaps more intelligible to describe it separately.

The sphenoid bone is articulated with all the bones of the scull at the points already indicated, and with the following bones of the face—the malar, the palate bones, and the vomer, sometimes with the superior maxillary.

It consists, when fully formed, chiefly of compact bone; for the plates even of its cells, though thin, are compact and firm bone, and its general density is considerable.

In the fœtus the sphenoid bone, after remaining cartilaginous till the third month, begins to ossify in the lateral portion, near the roots of the pterygoid processes. Two other points of ossification appear on the large wings, and, coalescing with those already formed, constitute a single mass on each side for each lateral portion. About the same time the body in the sella Turcica begins to be formed; and shortly after the small wings are formed separately, and coalesce, first with each other, and then with the body. In the fifth month the bone has the same figure which it retains through life, but the extremities of the wings are soft and cartilaginous; the body of the bone is uniform, loose, bony matter; the holes are large and imperfect; the optic hole is triangular; the inferior maxillary hole and the spinous are incomplete behind—sometimes the latter is not formed; and the Vidian canal is a mere fissure between the base of the external and internal pterygoid processes. The bone at this time consists of five portions, one for each small wing, one for each large wing, and one for the body of the bone. At the period of birth, though these parts are still separable, in general the small wings become united with the body, and the bone thus consists of three pieces. Eventually, by the union of the two large wings with the sides of the body, the bone is consolidated into one portion, the optic foramen is rounded, the oval hole completed, and the Vidian fissure is at the same time converted into a canal. In this state the sphenoid continues for several years, growing in every direction, and diminishing the size of its several apertures; till, about the age of puberty, the body becomes excavated into two lateral cavities with compact walls, separated by middle partitions. These are the sphenoidal sinuses, the formation of which is generally simultaneous with the completion of the bone in all its parts.

The occipital bone.

The occipital bone (*os occipitis, os proræ*), symmetrical, of a rhomboidal or trapezoidal shape, placed on the median line, occupying the posterior inferior region of the scull, may be distinguished into three parts, the occipital bone proper, the condyloid processes, and its cuneiform or basilar process. It presents two surfaces, an external or occipital, and an internal or cerebral.

The external surface is convex and smooth above the middle, where it is covered by pericranium and the tendinous fascia of the occipito-frontal muscle. Nearly in the middle the bone is elevated into an irregularly triangular eminence named the occipital protuberance (*tuber occipitis*), the size and shape of which vary according to the energy of the muscles connected with the strong fibrous fascia named the cervical ligament. When most strongly marked, the apex of the protuberance to which the *trapezius*, by means of the ligament now mentioned, is fixed, is prominent downwards, and occasionally incurvated or unciform. From this prominence a line may be traced, obscurely at first, distinctly below, descending to the great aperture (*foramen magnum*), for the transmission of the spinal chord. To this ridge or crest (*crista occipitis*), which is not always exactly in the middle, a fibrous fascia of great strength is attached, from the protuberance to the aperture, giving support and attachment to the muscles on each side, and named the posterior cervical ligament (*ligamentum cervicis, ligamentum nuchæ*). On each side of this ridge the surface is marked by various irregularities, the effect of muscular impressions.

A semicircular ridge, extending from the protuberance on each side to the margins, where it joins a similar ridge on the temporal bone, and named the *superior semicircular*, gives attachment above to the occipital part of the *epicranius*, the lateral parts of the *trapezius* below, and at its marginal end to that of the sterno-mastoid. When the crest begins to be distinct, a similar ridge proceeds in a semicircular direction to the margins of the bone, where it becomes more elevated, and occasionally changes its direction by a slight bend downwards and forwards. To the space between these two lines, which is rough and irregular, the *complexus*, and part of the *rectus capitis posticus major*, are attached within, and the *splenius capitis* without; while the *rectus capitis posticus major* and *minor*, and the *obliquus capitis superior*, are inserted by a strong fascia into the superior semicircular line. (Plate XXIV. fig. 6.)

The lower region of the bone presents the vertebral aperture, generally oval, with the large diameter antero-posterior, sometimes circular, occasionally rhomboidal or lozenge-shaped. At its anterior half are the condyloid processes, tipped with cartilage and synovial membrane, elliptical in shape, converging forwards, and parted by a sinuosity in the posterior part of the cuneiform process. By this opening the spinal chord with its membranes, and the spinal nerves, pass outwards, and the vertebral arteries enter the cranium. The posterior extremity of the condyloid processes is bounded by a depression, containing generally a small hole, sometimes two, for the transit of vessels not constant; externally is a rough surface, for the attachment of the *rectus capitis lateralis*; and above is the anterior condyloid hole, for the transmission of the twelfth cerebral or hypoglossal nerve.

The portion of bone anterior to the great aperture is the cuneiform process, the outer surface of which is depressed behind for the insertion of the *recti capitis interni majores* and *minores*; but smooth before, where it is covered by the mucous membrane of the pharynx.

The internal or cerebral surface, which is concave, is divided more or less regularly into four compartments, in the following manner. From the apex descends a groove nearly in the median line, though generally inclining a little to the right, to near the middle between the apex

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The occipital bone.

and upper margin of the great aperture, where it makes a rectangular turn to the right, leaving in the middle an elevated eminence, on the other side of which a similar groove, though always smaller, proceeds to the opposite margin of the bone, while from the same point descends an elevated ridge, more or less acuminated, to within half an inch of the great aperture. This arrangement produces in the inner surface of the occipital bone a cruciform appearance, which is occasionally named the *spina cruciata*, while the compartments are distinguished as superior and inferior right and left occipital *fossæ*. The rectangular groove, which is the continuation of the sagittal, formed in the inner surface of the parietal bones, contains first the lower part of the superior longitudinal sinus, then the lateral sinus, the plates of the *dura mater* being fixed to the lateral ridges on each side. The groove on the left side contains the left lateral sinus; and to the central tubercle and ridge the *falx* of the *cerebellum* is attached. In the two upper compartments, which are much marked by cerebral eminences and depressions, the posterior cerebral lobes are lodged, while the cerebellic lobes are contained in the inferior compartments. (Fig. 7.)

On each side of the large aperture is seen a short segment of a broad circular furrow, which terminates on the margin of the bone in a smooth sinuous depression. The first part is the termination of the lateral groove, containing the end of the lateral sinus; the second, the sigmoid notch, forms, with a similar one on the temporal bone, the jugular hole (*foramen lacerum posterius in basi cranii, foramen jugulare, incisura jugularis*), for the commencement of the jugular vein, the glosso-pharyngeal nerve, the *nervus vagus*, and the accessory nerve. Occasionally there is a proper notch for the *nervus vagus* in the anterior part, and occasionally one for the glosso-pharyngeal.

Anterior to the large aperture is the inner surface of the cuneiform process, concave transversely for lodging the *medulla oblongata* before it quits the cavity of the cranium (*fossa basilaris*), marked by a groove at the sides for the inferior petrous sinuses, and terminating abruptly in a broad quadrilateral surface incrusted with cartilage, for articulation with the posterior part of the sphenoid bone.

The margins of the occipital bone posterior to the inferior lateral groove are serrated for articulation by suture with the parietal and temporal bones. The upper margins form a salient angle, nearly rectangular, for articulation with the re-entrant angle formed by the two parietal bones. The sides of this angle, however, vary in direction from the presence or absence of Wormian bones (*ossa Wormiana, triquetra*). Another salient angle, but always obtuse, is formed opposite the superior lateral grooves, for articulation with the re-entrant angle formed by the parietal and temporal bones of each side. A third angle is formed by the jugular eminence, an elevated process placed between the inferior lateral groove and the jugular notch, and which is tipped with cartilage for articulation with a corresponding surface of the pyramidal portion of the temporal bone. Anterior to the jugular notch the margin of the bone is smooth, but articulates by fibro-cartilage with the posterior surface of the temporal pyramid, leaving a small space unarticulated between the anterior extremities of both bones, which form a common aperture.

The occipital bone is thick along the crucial spine, the tubercles, and at the condyloid process; but thin in the centre of the four occipital fossæ, at which the external and internal tables are united with little or no *diploe*, and are not unfrequently translucent. The cuneiform process is cancellated.

In the fœtus it consists of four pieces, one for the occipital bone proper, one for each condyloid portion, and one for the basilar process. The ossification of the occipital portion commences near its middle, corresponding to a point above the occipital protuberance, and extends by radiating fibres all round to the margins of the bone. At this time the occipital portion has the shape of a *cardium;* and the apex not being formed, a space is left through which the brain is felt pulsating, named the posterior fontanelle. About the same time ossification appears in two quadrilateral portions on each side of the large aperture, and in an oblong parallelogram anterior to it. Though these enlarge and approach each other, at the period of birth the apex is still incomplete, and the posterior fontanelle is open; and even at the inferior angles of the occipital portion, where it joins the condyloid portions, a space of the same kind is left on each side. After birth, as ossification advances rapidly, the apex of the occipital portion is gradually enlarged, the Wormian bones on each side are formed, and the condyloid and basilar portions uniting with the occipital, the bone is consolidated about the third or fourth year. The traces of the lines of union may sometimes be recognised so late as the seventh year.

The occipital bone is articulated immovably by its margins with the sphenoid bone, the two parietal, and the two temporal bones; movably by its condyles with the atlas.

It is also connected with the second vertebra by means of a ligament, which passes from the odontoid process to the inner margins of the condyloid processes.

The parietal bones.

The parietal bones (*ossa verticis, ossa bregmatis, ossa parietalia*), two bones united with each other on the mesial line, are quadrilateral, quadrangular, convex externally, concave internally, occupying the upper, middle, and lateral parts of the cranium. (Plate XXVI. fig. 4 and 5.)

The external convex surface, which is covered by the *epicranius* above and temporal muscle below, presents above and behind a hole for an artery and vein, variable however in position and existence; in the middle the parietal eminence, prominent in youth, indistinct in advanced age; and somewhere between its middle and lower margin a curvilinear ridge, the continuation of that on the frontal bone, and terminating near the lower angle of the parietal for the attachment of the temporal fascia, below which the bone is covered by the temporal muscle.

The internal concave surface, lined by the *dura mater*, is marked by digital eminences and depressions corresponding to those of the cerebral convolutions. The superior edge is marked by a half-groove, which, with that of the opposite bone, constitutes the sagittal for lodging the superior longitudinal sinus; within this, depressions more or less deep, corresponding to the granules of Pacchioni; towards the centre the parietal pit, corresponding to the eminence of the external surface; and ascending from the inferior anterior angle arborescent grooves, in which the large meningeal artery is lodged. (m, m.) Parts of these grooves are occasionally converted into canals by the growth of bone over their margins.

The parietal bone is bounded by four margins. By the superior, which is serrated, it unites on the mesial plane with the opposite bone, forming the *sagittal suture;* by the anterior or coronal, also serrated, it is articulated firmly with the frontal bone, forming the *coronal suture;* and the posterior, also serrated, forms with the posterior margin of the corresponding bone a re-entrant angle, in which the occipital, occasionally with Wormian bones, is articulated. The lower margin alone, which is a concave curvature, is obliquely acuminated before, acuminated and serrated in the middle for imbrication with the temporal

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bone, and serrated behind for articulation with the upper margin of the mastoid process.

The parietal bones.

These margins form by union four angles, an anterior and posterior superior, and an anterior and posterior inferior, of which the most important is the anterior inferior, by reason of its presenting the origin of the meningeal groove on its internal surface. The parietal bone, consisting of an external and internal table, with interposed *diploe*, is thin, especially below its middle; and the *diploe* is small, and in some points obliterated. It is ossified from one point, commencing at the protuberance, and radiating all round to the margins. Previous, and some time subsequent to birth, its mesial margin and anterior and superior angle are not formed; and the brain is here covered by *dura mater*, *pericranium*, and integuments only, forming, as already mentioned, the *bregma*, or anterior fontanelle. By the completion of the bones, however, the margins and angles meet, and the fontanelle is closed. This is generally effected in the course of the second year.

The temporal bones.

The temporal bones (*ossa temporum*), rather irregular in shape, are placed on each side at the lateral and inferior parts of the cranium.

Each bone presents an external or auricular surface, an internal or cerebral, and a circumference.

The external or auricular surface presents, above and before, a large convex surface, part of the temporal fossa lodging part of the temporal muscle; before, the zygomatic process, long, pointed, and terminating in a serrated extremity, where it is united with the malar bone to form the *zygoma* (fig. 2, z), to the upper surface of which the temporal fascia is attached, to the lower the masseter muscle; behind, a flat surface of an irregularly rounded shape, terminating before in the mastoid process (*processus mammillaris, mastoideus*, m), and behind in a serrated margin, which unites with the occipital bone. Between the mastoid process and the serrated margin behind is a rough surface for the *splenius*, small *complexus*, and sterno-mastoid; and below is a pit, in which the origin of the digastric muscle (*biventer maxillæ*) is lodged.

The zygomatic process is connected to the temporal bone by two roots, one of which, anterior, inferior, and transverse (*processus transversus*), forms the anterior brim of the glenoid or articular cavity, in which the condyle of the inferior jaw is lodged; the other, superior and posterior, forms first the external and then the posterior brim of the same cavity. Behind this posterior brim is an irregular fissure termed the glenoid (*fissura Glasseri*), which indicates the original line of separation between the superior or squamous and the inferior or pyramidal portion of the bone, and through which pass the tendon of the anterior muscle of the *malleus*, some vessels, and a nervous twig named *chorda tympani*.

In the angle between the mastoid and zygomatic process is an elliptical opening from five to six lines in diameter, leading into a cylindrical cavity, the direction of which is obliquely forwards. This orifice, which is the external ear-hole (*meatus externus*, o), leads into the tympanal cavity, from which it is separated, in the recent subject, by a thin membrane only (*membrana tympani*). The three lower thirds of this orifice are formed by a distinct bony ring, which is rough, and perforated by holes for the insertion of the cartilages of the external ear. On the outside of the lower part of this bony ring is a strong process, varying from half an inch to 12 lines in length, nearly round, but terminating in a sharp point, and therefore, from its resemblance to the style of the ancients, named the *styloid process*. (σ.) Behind its base, and between it and the mastoid process, is a small hole, the stylo-mastoid, for the exit of the facial nerve. (Plate XXVI. fig. 2.)

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The temporal bones.

The inner or cerebral surface, marked by cerebral impressions and arterial furrows, is distinguished particularly by a pyramidal eminence of bone rising obliquely from it, and a deep sinuous groove, making part of the lateral, in which is lodged part of the lateral sinus.

The pyramidal portion (*pyramis*, fig. 3, p), named also the petrous (*pars petrosa*), from its hardness in several of the lower animals, may be distinguished as a truncated pyramid, bounded by four planes, one of which, the external, has been already described. Of the other three, one superior, marked by cerebral impressions, presents a semilunar depression for the Gasserian or trigeminal ganglion, the upper orifice of the carotic canal, a slight furrow, the extremity of the opening through which a branch of the Vidian nerve passes, and an eminence which indicates the situation of the superior semicircular canal. Another posterior, separated from the last by a sharp margin, traversed anteriorly by the groove of the superior petrous sinus, presents, first, an eminence indicating the posterior semicircular canal; and, secondly, an orifice, the internal auditory hole (*meatus internus*), parted by a septum into an upper orifice communicating with the Fallopian aqueduct for the facial nerve, and a lower pit containing minute holes communicating with the labyrinth, and transmitting the filaments of the eighth or auditory nerve.

The lower or third plane surface of the pyramidal process, which is external and connected with the occipital bone, presents, first, at the lower end of the external depression a cartilaginous, rough surface, where it adheres to that bone; then a large sinuous cavity, the jugular notch, forming, with that on the occipital bone, the hole for the exit of the jugular vein, often separated by a bony process into two, the first of which is for the *nervus vagus*, the second for the jugular vein; a sharp ridge (*processus vaginalis*) at the base of the styloid process, separating the jugular notch from the glenoid cavity; a circular hole, the external orifice of the carotic canal (*canalis caroticus*), for the entrance of the internal carotid and the exit of the sixth nerve; a small hole terminating the aqueduct of the *cochlea*; and, lastly, a rough surface for the attachment of the internal *peristaphylinus*, and the external muscle of the *malleus*. At the line of junction between this plane and the posterior is generally seen part of the groove for the inferior petrous sinus. (Plate XXVI. fig. 3.)

The circumference is united behind by a serrated margin with the occipital bone; above by a margin, partly serrated, partly imbricated, with the parietal bone and posterior part of the large wing of the sphenoid; and before and below by a serrated margin with the lower part of the same wing. This part, named generally the squamous, forms with the pyramid a re-entrant angle, in which is received the spinous process of the sphenoid bone; and close beside which is the orifice of the Eustachian tube (*iter a palato ad aurem*), the canal which leads from the throat to the tympanal cavity. The truncated extremity of the pyramid, which is received by the re-entrant angle formed by the sphenoid and occipital bones, presents the upper opening of the carotic canal, which is imperfect above, and in the recent body is completed by the *dura mater*.

The temporal bone is thin before and above, where it consists of two tables with intermediate *diploe*. The mastoid process in the adult consists of numerous communicating cells, lined by very delicate periosteal mucous membrane, continued from the tympanal cavity, with which they communicate. The pyramidal portion is compact and hard, and contains with other parts the labyrinth or internal ear.

Nothing is more interesting than the developement of

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The temporal bones.

the temporal bone. It is ossified in three portions,—the large, flat, or squamous; the tympanal ring; the pyramidal, with the mastoid, and the styloid process.

At an early period the pyramidal portion is perfectly formed round the several soft parts, and though porous and spongy, dense bone is seen in the site of the semicircular canals. The different orifices are large and distinct. The tympanal cavity, however, is quite incomplete; and though the carotic canal is formed, the Eustachian tube is in the shape of a mere groove. The size of the pyramid is greater than subsequently in proportion; and the part behind the open tympanal cavity, which is bulky, is to constitute the mastoid process, which however is still a shapeless mass. The squamous portion is thin and almost scaly at birth, with the zygomatic process well marked, and a ring of bone, incomplete at the upper margin, attached to its inferior and posterior part. By this, which afterwards constitutes the ring of the external ear-hole, it is fixed to the pyramidal portion in such manner that the part behind the ring is rather larger and longer than the part before; and the pyramid, instead of projecting, as afterwards, is short and thick. At this period also the flat portion uniting with the occipital bone is not formed, and there is therefore an opening or fontanelle at this point of the cranium. Soon, however, the squamous becomes united with the pyramidal portion; the tympanal ring is fixed to both; the Eustachian tube is completed; and, at the posterior end of the pyramid, bone is deposited and extended in a tabular layer of some thickness. The mastoid process, however, cannot be recognised; and it is only some years after birth (about seven) that a small oblong elevation begins to be visible behind the posterior limb of the auditory ring. If at this time the process is divided, cells of the kind afterwards seen in this part are not distinct; but as its enlargement proceeds, cells begin to be formed about the same time, and at the same rate, as the frontal, ethmoidal, and sphenoidal cells are formed. The figure of the bone also is altered, in consequence of the change which the component parts undergo in relation to each other. The squamous portion expands, the anterior part of the pyramidal portion is elongated and tapers, the posterior and the mastoid parts enlarge, and at a later period the styloid process begins to appear amidst the muscles attached to it.

The temporal bone is united immovably with the sphenoid, parietal, occipital, and malar bones; and the inferior maxillary is connected to it by articulation. In the tympanal cavity, also, are contained the four tympanal bones, to be considered afterwards.

Wormian bones.

Besides these uniform bones of the cranium, there are occasionally found one or more supernumerary bones, which vary much in number, size, and situation. Most usually they are found in the line between the occipital and parietal bones, causing the lambdoidal suture to vary much in regularity; and occasionally, instead of the apex of the occipital bone, is found a single supernumerary bone. They are observed less frequently at the inferior anterior angle of these bones, and at the temporo-parietal sutures, and still more rarely at the base of the cranium. These bones, to which attention was originally drawn by Wormius, by whose name they are still distinguished (*ossa Wormiana*), may be regarded as effects of the aberration of the ossific process. Though they have been also named triangular (*ossa triquetra*), their shape is extremely variable. They are similar in structure and mode of union to the parietal and occipital bones; and though they are not entitled to the epithet of cranial keys (*claves cranii*), often given them, they may be viewed as appendages to the cranial bones, which are then to be regarded as incomplete. The most important fact in their history is, that they are most frequent in young subjects, and in those in whom ossification is imperfect. As they are rarely found in advanced age, it may be inferred that they eventually become consolidated with one or other of the bones to which they adhere.

§ 5. *The Face.* (*Ossa Faciei.*)

The face.

The face, situate before and below the cranium, is bounded above by that cavity, on the sides by the zygomatic arches, and behind by a space corresponding to the upper region of the pharynx. Symmetrical in disposition, its anterior surface is trapezoidal, the largest side being above, its vertical section triangular, and each side irregular. The bones of which it consists are those of the upper jaw, comprehending thirteen separate pieces, two superior maxillary bones, two malar bones, two nasal bones, two lacrymal bones, two inferior turbinated bones, two palate bones, and one vomer; and the single lower jaw. (Plate XXVI. fig. 8.)

The upper jaw-bone.

The superior maxillary bone (*os malæ, maxilla superior*) is the basis of those of the upper jaw, and forms a centre, with which the others are connected. Though in shape irregular, it may be distinguished into zygomato-facial, orbitar, and naso-palatine surfaces. (Fig. 6.)

The zygomato-facial surface, irregularly convex and concave, consists of two divisions, the facial and zygomatic. The first presents the nasal or ascending process, terminating above in a serrated margin, articulated with the frontal bone; behind in a groove concurring with a similar one in the lacrymal bone to form the lacrymal canal; before by a similar margin joining with the nasal bone; and below, a pit for the insertion of the levator of the upper lip and nose (*levator labii superioris alæque nasi*). The facial surface below this, bounded on the mesial side by a sinuous hollow, the nasal, and a spine forming with that of the opposite side the nasal spine, presents above, the superior maxillary hole for the exit of the second branch of the trigeminal nerve, the canine *fossa* for lodging the *levator anguli oris*, separated by an elevation from the incisive *fossa* for lodging the myrtiform muscle (*depressor alæ nasi*). The facial region is separated from the zygomatic by a rounded margin, the upper extremity of which is rough and hollowed for articulation with the malar bone (*os genæ, os jugale*); while the posterior forms part of the temporal *fossa* before, and a distinct protuberance behind corresponding to the posterior part of a large cavity denominated the maxillary (*antrum maxillare, sinus maxillaris*). This cavity, indeed, corresponds also to the canine fossa and the external protuberance.

The orbitar surface, which is flat, and slightly oblique in direction, forming the inner half of the lower wall of the orbit, is bounded within by a sharp line for articulation with the ethmoid bone, without by the rough malar surface, and traversed through its posterior half by a groove for the maxillary vessels and nerve, terminating partly in the sinus, partly in the superior maxillary hole. The posterior margin of this surface, which is obtusely rounded, forms with the sphenoid bone the spheno-maxillary fissure; and its internal or mesial angle is articulated with the ascending process of the palate bone.

The naso-palatine or mesial surface of the bone is complicated. Before and above is seen the inner surface of the nasal or ascending process, traversed by vascular and nervous grooves, and covered by the pituitary membrane. Behind this is the lacrymal groove, terminating in the nasal, which is converted into a canal by the inferior turbinated bone, below which it opens; and the open-

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The superior maxillary bone.

ing into the maxillary sinus, large in the detached bone, but contracted below by the inferior turbinated, and behind by the palate-bone. This sinus, which is of an irregular tetrahedral shape, corresponds before to the canine *fossa*, behind to the zygomatic tuberosity, above to the orbitar plate, and below to the alveolar arch. Below this is the palatine plate (*apophysis palatina*), quadrilateral and horizontal, concave and smooth above, where it forms the lower wall of the nostrils, concave and marked by vascular orifices below, where it forms the anterior part of the hard palate. (Fig. 7.) The anterior part of the process is elevated into the nasal spine; its mesial margin, which is thick and marked by numerous grooves, one unusually large for the naso-palatine nerves and vessels (*canalis incisivus vel Stenonianus*), is joined to that of the opposite side, forming a groove in which the lower margin of the vomer is received; and the posterior, which is thin, is attached to the square plate of the palate-bone, which thus completes the palatine vault.

The palatine is separated from the zygomato-facial region by a semiparabolic arch, perforated in the adult by eight honeycomb-like pits (*alveoli*), in which the roots of the teeth are implanted, and therefore named the *alveolar* arch. Of these pits the first two are the smallest, the next three larger, and the last three very large,—an arrangement which renders the alveolar arch narrow before, and broad on the sides and behind.

The superior maxillary bone is united, at the points indicated, to that of the opposite side, to the frontal bone, to the ethmoid, to the nasal, to the lacrymal, to the palatine, to the malar, to the inferior turbinated bone, and to the vomer.

It is ossified in one piece. In the fœtus its divisions are completely formed, except the orbitar plate, the sinus, and the *alveoli*. In the former, the superior maxillary canal is a slit; and the latter is a mere depression on the nasal surface of the bone. This, however, becomes larger and more capacious, not by excavation, but by the extension of its walls by bony deposition. The alveolar arch in general consists of two parabolic plates united by transverse *septa*, so imperfect, that the whole intermediate groove communicates freely. These osseous plates are not uniform in number. In some maxillary bones there are four, and a fifth like a mere line at the bottom of the groove; in others six *alveoli*, viz. four temporary, and two permanent *alveoli*. These plates are formed by deposition round the dentiferous sacs.

The malar or cheek-bone.

The malar bone (*os jugale, os genæ*) is a quadrilateral bone, approaching the rhomboidal shape, but bounded by curved lines. It presents three surfaces, a facial, an orbitar, and a zygomatic; and four angles, a frontal, a temporal, a zygomatic, a superior maxillary, and an inferior maxillary. (Fig. 7 and 8, g.)

The facial surface is convex and smooth, marked by one or two holes (*foramen jugale*) for vessels and nerves, and, with the zygomatic process gives attachment below to the zygomatic muscles.

The orbitar surface, which is concave, directed obliquely upwards, projects backwards from the facial plate, and forms the outer wall of the orbit between the frontal and sphenoid bone above, and the superior maxillary below. It presents the internal malar hole, or the inner orifice of that seen in the facial surface. The posterior edge is rough and serrated for conjunction with the sphenoid bone.

The zygomatic surface is a sort of angular concave recess between the orbitar plate above and the facial before, and is chiefly important in forming the anterior part of the temporal fossa. In the angle between the orbitar and facial plates is seen a small hole, which communicates with the internal malar above, and the external malar before. The anterior part of this surface is rough, and unites with the external or malar process of the superior maxillary bone.

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The cheek-bone.

The superior or frontal angle is serrated for uniting with the external angular process of the frontal bone. The temporal is long and pointed, and rough above, where it joins the temporal bone to form the *zygoma*, to which the temporal fascia above and the masseter below are attached. The superior maxillary or orbitar is also pointed, and joins the rounded ridge at the base of the ascending process of the superior maxillary bone. The inferior maxillary is obtuse-angled, and joins the lower angle of the malar process.

Wedged between the bones of the scull and face, the malar bone is connected to the frontal, the temporal, the sphenoid, and the superior maxillary. It is ossified from a single point.

The nasal bone.

Each nasal bone (*os nasi*) is quadrilateral and trapezoidal. Of its two surfaces, the external, smooth and slightly convex, is covered by the periosteum and the pyramidal muscle (*compressor narium*) and part of the frontal (*epicranius*). The inner, rather concave and somewhat irregular, with grooves for vessels and nerves, is covered with the pituitary membrane. (Fig. 8, n.)

The upper margin of the nasal bone, which is somewhat thick, is serrated for union with the frontal bone, on the nasal spine of which it is firmly supported. By the mesial margin, which also is thick, plain, and prolonged backwards, it is joined to that of the opposite side; while its thin external margin being imbricated beneath the mesial one of the maxillary, the central pressure is thus opposed on each side. In this manner the two nasal bones, supported above by the frontal spine, are firmly wedged between the superior maxillary, much on the same principle as the key-stone is wedged between the lateral parts of the arch. (Plate XXIV. 2 and 3, n.) To the lower margin the nasal cartilages are attached. Each nasal bone is formed from a single centre of ossification.

The lacrymal bone.

Each lacrymal bone (*os lacrymale, os unguis*) is about the size of a nail, situate at the inner wall of the orbit, occupying the space between the frontal bone above, the ethmoid behind, and the superior maxillary before. Its shape is irregularly quadrilateral, and it presents two surfaces, an orbitar and nasal, and four margins.

The orbitar surface consists of two regions, one orbitar proper, flat, and smooth, situate behind, and connected with the lateral smooth bone (*os planum*) of the ethmoid, with which it completes the inner wall of the orbit; the other, which is anterior, is at right angles to this, and is moulded into a cylindrical groove, which, with that of the superior maxillary bone, constitutes the lacrymal canal, in which is lodged the membranous tube which conveys the tears and mucus from the eye to the nose. These two surfaces are parted by a sharp longitudinal crest, to which is attached the aponeurosis of the orbicular muscle of the eyelids (*orbicularis palpebrarum*).

The nasal surface is irregular, covered by the fibromucous membrane of the ethmoid cells, and of which it makes part. It presents distinctly the angle of union between the orbitar and lacrymal portion of the bone.

This bone, which is compact, is developed from a single point, and is early formed in the fœtus.

The inferior turbinated bones.

The inferior turbinated bones, which are irregular in shape, are attached to the nasal surface of the superior maxillary by an oblique line near the lower margin of the *antrum*, with the convex surfaces turned to each other.

Each turbinated bone presents a nasal surface, uneven and marked by rough lines, with intermediate cellular

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grooves; and a maxillary one, concave, and constituting part of the inferior nasal passage. Both are invested by fibro-mucous membrane continued from the pituitary.

The turbinated bones.

Each turbinated bone is bounded by two margins,—a superior, which is fixed,—an inferior, free. Of the former, the anterior part is a thin border, joining with the superior maxillary bone at the base of the ascending process, and with the lacrymal bone by an angular slip. The middle is a short spinous part, uniting with the lateral mass of the ethmoid, and diminishing the opening of the maxillary sinus; and the posterior part, which is rounded and inclining, is attached to the crest of the palate-bone. The lower margin, which is free, is slightly convoluted on itself, so as to separate the middle from the inferior nasal passage.

The inferior spongy bone, which is formed in one piece, though perforated by vascular and nervous holes, and moulded into cells at its lower convoluted margin, consists, however, chiefly of compact bone. It is covered through its whole extent by the fibro-mucous membrane of the nasal passages.

The palate bones.

Each palate-bone (*ossa palati*), attached to the posterior part of the superior maxillary bones, to which they may be regarded as appendages, consists of three parts, a base or palatine portion, a nasal ascending or vertical portion, and an orbitar part.

The base consists of a quadrangular and quadrilateral plate of bone, placed horizontally, and attached before to the posterior margin of the horizontal or palatine plate of the superior maxillary bone, and on the inner or mesial side to the corresponding margin of the opposite bone (Plate XXVI. fig. 7, p, p), with which it forms a groove, in which is lodged the posterior part of the lower margin of the vomer. The upper surface is concave, and, with that of the superior maxillary bone, completes the lower wall of the nasal passages. The lower is almost straight, but presents a slight concavity, bounded behind by a transverse crest of bone, to which the *uvula* or soft and movable palate is attached. Behind this is a surface bounded by the posterior margin, which is sinuous and lunated, and terminates within in a pointed eminence, which, with that of the opposite side, forms on the mesial plane the palatine spine. The external margin, which rises into the nasal or ascending portion, is rounded without into a sinuous depression, which forms, with the pterygoid process of the sphenoid bone, the pterygo-palatine canal, and which occasionally, at least at its lower extremity, is entirely formed in the palate-bone.

The nasal portion, which is irregular in shape, presents on the nasal surface a hollow, rising from the square plate, and forming the posterior part of the lower nasal passage; a transverse ridge (*linea aspera*) continuous with that of the superior maxillary bone, and to which the inferior turbinated bone is attached; and then another hollow, forming the posterior end of the middle nasal passage, and with the former contracting the orifice of the maxillary sinus. Immediately above this the vertical portion is parted by a notch into two unequal parts, a posterior articulated with the base of the external pterygoid process, and an anterior articulated before with the superior maxillary bone, and within presenting cells, which unite with those of the ethmoid bone. The outer part of this cellular portion is bounded by three surfaces, one external, forming part of the zygomatic *fossa;* another anterior, resting on a corresponding surface of the superior maxillary bone; a third superior, forming part of the inner wall of the orbit. The notch between the anterior and posterior divisions forms with the sphenoid bone the spheno-palatine, for transmitting the spheno-palatine twig of the superior maxillary nerve, with some veins, and the internal branch of the spheno-palatine ganglion.

The palate bones.

The posterior margin of this vertical portion is acute above, where it is simply conjoined with the base of the pterygoid processes; but below it is moulded into a thick, strong, triangular process, projecting backwards, and marked by three grooves, one in the middle, and one on each side. In the two latter the external and internal pterygoid processes are adapted; and the middle space, being prominent, and firmly wedged between the pterygoid processes, completes the pterygoid *fossa.*

Each palate-bone is connected with six bones, two of the cranium and four of the face; the ethmoid and sphenoid, the superior maxillary, the inferior turbinated bone, the palate-bone of the opposite side, and the *vomer.*

The palate-bone, so far as is hitherto observed, is formed in one portion. In the fœtus, at the seventh month, it is completely formed; but the square or horizontal part is larger in proportion than the vertical, and remains so till the face begins to alter its shape.

The vomer.

The *vomer* or plough-share bone is symmetrical, placed on the mesial plane between the sphenoid and ethmoid bones above, and the palate and superior maxillary bones below, and forming the posterior part of the nasal partition.

In shape it is irregular, though it affects the rhomboidal. It consists of two thin plates of compact bone united at an angular line below, but separated above so as to form a deep longitudinal groove, in which the cartilaginous partition before, and the vertical plate of the ethmoid behind, are inserted. At the posterior end these plates spread out into lateral wings with intermediate grooves, in which the *azygos* process of the sphenoid bone is accurately fitted. These two parts form the upper and posterior margins. The lower consists of a single thin plate, which is received into the linear groove formed by the middle crest of the palate and superior maxillary bones. The anterior part of this margin rises more directly, to fit the nasal spine of the latter bones.

The surfaces of the vomer are smooth, occasionally concave and convex in opposite directions, and, being covered by the fibro-mucous pituitary membrane, constitute the bony partition between the right and left nasal passages. The bone is formed in a single piece, and is generally completed in the seventh and eighth month.

The lower jaw.

The lower jaw-bone (*mandibula, maxilla inferior*), symmetrical, placed at the base of the face, is of a shape nearly parabolic, with an elevated branch at each extremity. It consists of two parts, a maxillary arch, and a *ramus* at each end, each of which has two surfaces, an external or facial, and an internal or oral, an alveolar or upper margin, and a mental or lower margin. (Fig. 8 and 9.)

The external surface of the parabolic or arched portion of the lower jaw presents first on the mesial plane the *symphysis* or chin (*mentum*), indicating the original separation of the bone into two parts,—a vertical line diverging into two, so as to form a triangular eminence (*tuber maxillare* of Soemmering). (Fig. 8 and 9, x.) On each side of this is a depression for the tuft or *levator* of the chin, the anterior mental hole (*foramen menti anterius,* f), or inferior maxillary for the exit of the third branch of the fifth pair, and the external maxillary line (*m*) for the insertion of the *platysma, depressor anguli oris,* and *depressor labii inferioris.* Behind this the ascending *ramus* presents a quadrilateral surface, corresponding to the masseter (r), bounded before by a sharp line terminating in the coronoid process (b, b), behind by an obtuse one, the posterior margin terminating in the condyloid or articular process (c, c), and above by the sigmoid notch (*incisura semilunaris vel sigmoidea*) between them.

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The internal or oral surface of the lower jaw presents in the middle a spine or crest (*spina menti interna*), consisting in general of three eminences, the two superior of which give attachment to the *genio-glossi*, and the lower to the *genio-hyoidei*. On each side of this is a superficial hollow for the sublingual gland, and a pit for the digastric muscle; and extending outward on each side is the internal oblique line, to which the mylo-hyoideus and the superior constrictor of the pharynx are attached. Below this is a depression for the submaxillary gland; behind, at the margin of the *ramus*, the surface is rough for the insertion of the external pterygoid; between this and the top of the oblique line is the internal mental hole, or the inner orifice of the maxillary canal; and above and round the orifice the surface is rough for the insertion of the internal ligament of the lower jaw. By this orifice the inferior maxillary nerve, or third branch of the fifth pair, with its concomitant vessels, enters the canal; and after sending branches to the alveolar arch and membranes, reappears at the external mental hole.

The upper margin of the parabolic part of the bone is moulded into a series of *alveolar* or *honeycomb-like* cavities, bounded by external and internal plates, and separated by *septa* more or less complete. These cavities are in the adult 16 in number, but are sometimes imperfect, sometimes obliterated by the removal of the teeth. This margin, which, like the corresponding one of the superior jaw, is named the *alveolar arch*, is, like it, narrow anteriorly, and wide on the sides and behind. At the posterior end of each alveolar arch the external and internal oblique lines form between them a superficial depression, in which part of the *buccinator* is lodged; and then converging as they ascend, terminate in the pointed coronoid process, to which the tendon of the temporal muscle is fixed, unless at its outer surface, which is covered by the masseter. The condyloid process, separated from this by the sigmoid notch, is broad transversely, and is contracted below so as to form a neck, which is concave within for the insertion of the external pterygoid muscle.

The inferior margin, which is obtusely rounded, and forms a more pointed curve than the upper, gives attachment only to the cutaneous muscle (*platysma myoides*). The posterior margin, also obtuse, is free, but corresponds to the parotid gland, and is therefore occasionally named the parotid margin. To this the stylo-maxillary ligament is attached.

The posterior part of the bone, named the *ramus*, forms with its body an obtuse angle of about 100°, which diminishes as life advances. (Fig. 8, a, r.)

The inferior maxillary bone is connected movably with the temporal bone by its condyloid process being lodged in the glenoid cavity of the latter. In this situation it is retained by means of three ligaments, while its motions are facilitated by an interarticular fibro-cartilage.

The *external* ligament, composed of parallel fibres attached to the tubercle at the bifurcation of the zygomatic process, descends obliquely backwards, and is fixed to the outside of the neck of the condyle of the lower jaw. It is covered by skin and the parotid gland, and is lined by synovial membrane, to part of which the interarticular cartilage is attached. The *internal* ligament, attached to the spinous process of the sphenoid bone and its vicinity, proceeds obliquely downwards and forwards, between the two pterygoid muscles, expanding, to the orifice of the internal maxillary hole, round which it is attached.

The *stylo-maxillary* ligament is an aponeurotic chord, belonging rather to the *stylo-glossus* muscle, stretching between the styloid process and the tip of the angle of the lower jaw, where it is inserted between the masseter muscle without, and the internal pterygoid within.

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This articulation is so constructed that it possesses two synovial membranes, or at least a double one, the parts of which are separated by the interarticular cartilage. The latter body, which is of an oval shape, convex and concave above, to fit at once the glenoid cavity and the transverse process, but concave below for the maxillary condyle, adheres externally to the external ligament, while its inner margin is free. The upper division of the synovial membrane, therefore, adhering all round to the margins of the glenoid cavity and transverse process, after covering these parts, is reflected from the external lateral ligament over the upper surface of the interarticular fibro-cartilage. A minute slip may be then traced over the free margin of this fibro-cartilage, covering its lower surface, and thence continued over the inside of the external lateral ligament, and from it over the condyle of the lower jaw. In this manner the temporo-maxillary synovial membrane is rather composed of two parts, a superior and inferior, than absolutely double.

The inferior maxillary bone is formed in two pieces; and perhaps no bone in the human body undergoes from first to last greater changes in shape and extent than it does. In the fœtus, when first formed, it consists of two slightly incurvated portions, united on the mesial plane by cartilage, with the coronoid and condyloid process, and the intermediate sigmoid notch, rising from the posterior extremity of each. The *ramus*, however, cannot be said to be formed; and it is only some time after birth that the quadrilateral surface by which it is defined can be recognised. At birth, also, the alveolar arch consists only of two thin plates of bone, with scarcely perceptible traces of *septa*; and the periosteal coverings of the dentiferous sacs are in immediate contact with each other. After birth, bone is deposited between them, so as to form the transverse partitions of the *alveoli*, which afterwards increase in size and thickness with the bone itself, which enlarges in all its dimensions chiefly by extending backwards. Coalescing by the progress of ossification on the mesial plane, it is a few weeks after birth consolidated into one bone; and after the process of primary dentition commences, it loses the angular and acquires the parabolic shape. About the age of seven, sometimes previously, the body becomes more incurvated, and the posterior extremities enlarge backwards still more rapidly. As the process of secondary dentition advances, these extremities enlarge still more rapidly; and the angle of the jaw acquires a more prominent situation by becoming more depressed. At the time at which the facial and maxillary sinuses are formed, and the superior maxillary bone extends backwards to form its tuberosity, the posterior extremity gradually rises in the form of the *ramus*, till this part a year or two after puberty is fully an inch above the plane of the alveolar arch. During adolescence and middle life this is the condition of the jaw-bone. Towards the decline, however, the teeth drop out, and the alveolar processes are absorbed; and in old age the lower jaw consists often of a single cylindrical arch of bone placed between its two *rami*, which, retaining their original breadth and height, necessarily throw the body of the bone forwards beyond the upper alveolar arch.

The lower jaw-bone consists of two plates of compact bone, with cancellated tissue interposed, and traversed by the inferior dental canal, the walls of which, like the surface of the bone, are compact. This canal is subdivided into two parts,—one inferior, which terminates in the anterior mental hole, transmitting the mental branch of the inferior maxillary nerve; the other superior, which is parted into numerous minute passages into the *cancelli* of the bone and alveolar processes. These, it must also

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be observed, consist of a peculiar form of cancellated structure. Externally their bony walls are perforated by numerous minute well-defined holes, into which, in the recent state, the vessels and filaments of the alveolar periosteum penetrate. These orifices are so numerous in both maxillary bones, that a portion of alveolar process held between the eye and the light seems entirely perforated, and, if injected, becomes completely red. This character applies chiefly to the period of youth and adolescence. After this the alveolar processes become more solid, and eventually present much fewer orifices. This structure is the result of the manner in which the bony matter is deposited round the vessels and filaments of the periosteum, which may in this and similar bones be said to communicate in this manner with those of the medullary membrane.

The Teeth. (*Dentes.*)

The teeth.

The teeth, which are implanted in the alveolar cavities, though belonging properly to the digestive apparatus as organs of mastication, are nevertheless more conveniently considered in this place. (Plate XXVI. fig. 7, 8, and 9.)

In every tooth are recognised three parts,—the crown (*corona*), the neck or collar (*collum*), and the root (*radix*). The first is the portion which appears above the gum and alveolar process, and consists of a layer of enamel, thick above and round the top, but gradually extenuated below, inclosing a small portion of compact bone. The crown may be distinguished into the crown proper, or the *summit* or *apex* of the tooth, and the *fillet* or annular portion of enamel (*annulus*) by which the sides are surrounded. The root, which consists of compact bone, is the part which is implanted in the alveolar cavity, and the outer surface of which adheres to the inner or dental surface of the alveolar periosteum, and above that to the soft part of the gum. The neck is the narrow ring where the enamel ceases and the bone begins, and to which the gum adheres all round. This part, in short, belongs neither to the crown nor to the root, and perhaps is not justly entitled to any separate consideration, unless as the portion to which the gum adheres. The crown and root, on the contrary, are important, as furnishing the characters by which the teeth are distinguished into classes.

The incisor teeth.

These are three,—the incisor or cutting teeth (*dentes tomici, incisores, primores, risorii, acuti, adversi*); the canine or tearing teeth (*dentes canini, laniarii, cuspidati*); and the molar or grinding teeth (*dentes molares*).

The incisors are in number eight, four in each jaw, and two on each side of the mesial plane. All of them agree in having the crown or *apex* wedge-shaped, or like a carpenter's adze, convex before, and slightly concave behind, with the cutting edge crenated or notched. From the edge, also, which is broad, the fillet, which is quadrilateral, contracts much to the neck, and the root is bevelled in the opposite direction to that of the crown, so as to form a quadrilateral prism, and slightly acuminated. It is always simple and elongated. Its extremity presents an orifice communicating with the interior of the tooth, and admitting the vessels by which it is nourished. The crown is separated from the root by a narrow line, varying in position in the different kinds of incisors.

The incisors of the upper jaw are broader, thicker, longer, and in general more powerful, than those of the lower, and their axes are directed downwards and forwards so as to overlap in the motions of the lower jaw those of the inferior row, and leave a triangular interval with the base upwards. Their cutting edge also is oblique, so that its mesial angle is longer than its external; and their roots are larger and rounder. The central or middle incisors are larger, broader, and stronger, than the lateral ones.

The canine teeth.

The incisors of the lower jaw are smaller than those of the upper, and their axes are directed upwards and backwards, so that they are within the superior incisors. The central incisors also are larger than the lateral ones.

The canine or pointed teeth (*dentes cuspidati*) are four in number, one in each half of each alveolar arch, immediately next to the lateral incisors. These teeth are distinguished by prominent, thick crowns, with rounded convex fillets and pointed apices. The root also, which, like that of the incisors, is simple, is larger and thicker than in the latter. The upper canine teeth, which occasionally are named eye-teeth (*ocularii dentes*), are the longest and most prominent of all. During the elevation of the lower jaw, each inferior canine tooth is interior to the superior one, and is interposed between it and the lateral incisor.

Of the molar or grinders there are 20 altogether, being five in each half of each alveolar arch. They are subdivided into two orders, small molar or bicuspid teeth (*dentes bicuspidati*), and large molar or multicuspid teeth (*dentes multicuspidati*).

The molar or grinding teeth.

The molar teeth agree in having large, broad crowns, with tubercular summits, and roots, which, though occasionally single, are much more frequently two-fold, three-fold, or four-fold. The coronal tubercles are generally parted by a deep furrow, which gradually becomes shallow as the summits wear in the progress of years. When the roots are single, which is most frequent in the bicuspid order, each lateral surface is marked by a longitudinal furrow. When two-fold or manifold, they are parted by a fissure of variable width; and sometimes they diverge considerably. The annular furrow between the crown and root is very distinct.

The axes of the upper molar teeth are directed outwards, while those of the lower order, especially the most posterior, are directed inwards. More anteriorly they are occasionally vertical.

The small molar or bicuspid teeth.

The two molar teeth next to the canine, which have smaller crowns and roots, and are less in all their dimensions than the three posterior ones, are therefore distinguished as small molars. From the circumstance of their crowns being provided with two conical *apices*, one anterior, large, and the other posterior, parted by a transverse furrow, not dissimilar to the summits of two canine teeth conjoined in one, they were denominated by John Hunter bicuspid teeth (*bicuspidati*). These teeth are smaller than the canine, especially when their roots are single. The roots, however, are often bifid, and sometimes trifid. In the first case they are bevelled on the sides, and terminate in a point. In the second and third case they are conical. The internal surface of the bicuspid teeth is very generally narrower than the external, so that a transverse section would be trapezoidal, with the narrow margin posterior.

The large molar or grinders proper.

The *third* molar tooth, or the *first* large molar, is generally very large and strong, with the crown broad and quadrilateral, surmounted by four, five, or more tubercles, and the root trifid or quadrifid and divergent in the upper tooth, more frequently bifid only and divergent in the lower. The *second* large molar tooth, though rarely so large as the first, has the same general shape; the crown rhomboidal in the upper jaw, with four apices, and the root bifid or trifid and divergent.

The *third* large molar, named also wisdom-tooth (*dens sapientiæ*), from its late appearance, is smaller than the second, generally has a narrower crown, rounded, oblong,

Special Anatomy. The teeth.

quadrilateral, or rhomboidal, with two or three apices, and a narrow root generally single and conical, often incomplete. Its axis is strongly directed inwards, especially in the upper jaw.

The dental arches. The orders of teeth now enumerated constitute arches of a parabolic or semielliptical shape, larger in general in the upper jaw than in the lower. In the upper arch especially, the curvature is more rounded or elliptical; in the lower it is more angular and parabolic,—a circumstance which, with the different directions of the axes of the incisor and molar teeth respectively, causes the upper incisors to overlap, and thereby cut upon the lower ones, while the molars are fitted to each other so as to move on mutual surfaces in the lateral motion of the jaw.

Varieties. The teeth vary in number, shape, and position.

Though the general number of the adult or permanent teeth is 16 in each jaw, or 32 in all, it may happen that, in consequence of all the wisdom-teeth not coming through the gum, there are only 28 or 30. Occasionally also the lateral incisors are wanting. In some rare instances there is a supernumerary incisor or molar tooth; and Soemmering mentions an instance in which, by the addition of four molar teeth, the total number was augmented to 36. The union of two or more teeth into one is occasionally observed.

The most usual variations in shape are observed in the incisors being excessively large and broad, in the canine being very thick and long, ascending into the *antrum*, and in some rare instances extremely small. In females the canine teeth are occasionally so small and rounded, that they have the appearance rather of rudiments than of perfect teeth. The cleft roots of the molar teeth are liable to very great varieties in shape.

The most usual variety in position is when the incisors are placed obliquely, with their margins not lateral but antero-posterior. This is in general the result of the teeth being too much crowded in a small alveolar arch; and the malposition is always greatest as the jaw is narrow, or imperfectly formed. One or two incisors even in such circumstances may be entirely behind or before the rest, so as to give the appearance of a double row. The canine teeth are liable to the same change of position; but one greatly more frequent with them is, to be placed so much before the line of the arch as to project considerably forwards, like the tusks of some animals. Another form of this variety is, when teeth appear in unusual situations, for instance the palate or pharynx, or even in the orbit.

Dentition primary. The teeth are not at all periods of life the same in number. Generally speaking, at birth, when the teeth have not appeared above the gum, the rudiments of five teeth are found in each half alveolar arch. These, which are to constitute the milk-teeth, the deciduous or temporary, appear above the gum nearly in the following order: the central incisors of the lower jaw about the end of the sixth or beginning of the seventh month; a few weeks after, the central incisors of the upper jaw; after these, the lateral incisors above or below, without determinate order; and between the 12th and 18th months the first pair of molars, either above or below. These are followed by the lower canine teeth, and about the second year by the upper canine teeth. About the end of the second year, or in the course of the third, the second pair of molar teeth cut the gum; and about the fourth or fifth year in general, the third pair of molar teeth appear. The following table of the periods at which the different classes of temporary teeth appear, given by Mr Thomas Bell, may communicate a general idea of the succession.

From 5 to 8 months,	the 4 central incisors.
From 7 to 10	the 4 lateral incisors.
From 12 to 16	the 4 anterior molars.
From 14 to 20	the 4 canine.
From 18 to 36	the 4 posterior molars.

From these periods, however, there are extensive exceptions; and in no two individuals even of the same family does the same tooth appear at the same period.

Dentition permanent. About the seventh month the milk-teeth begin to appear above the gum; and about the seventh year they begin to be shed and succeeded by the permanent set. This process begins also in the lower jaw, and advances nearly in the same order: the lower central incisors; the upper, and the lateral above and below; the first pair of molar upper and lower; the second pair of molar above and below; the canine above and below; the third pair of molar; the fourth pair of molar in the eighteenth year; and the fifth pair, or wisdom-teeth, in the eighteenth, twentieth, or thirtieth years.

The average periods of eruption in the lower jaw are given in the tabular form by Mr Thomas Bell, in the following order.

The anterior larger molars	$6\frac{1}{2}$ years.
The central incisors	7
The lateral incisors	8
The anterior bicuspids	9
The posterior bicuspids	10
The canine or cuspidati	11—12
The second large molars	12—13
The third large molars, or wisdom-teeth	17—19

Those of the upper jaw are understood to follow these at an interval of two or three months.

In structure the teeth of the human subject belong to the order of simple teeth, that is, consist of bone, invested at the crown by enamel.

The hyoid or lingual bone. The hyoid bone (*os hyoides, υ, ossa lingualia*), though entirely unconnected with the skeleton, yet as a bone to which are attached various muscles of the throat, must be noticed in this place. It is a bone, or rather a bony apparatus, consisting of five separate pieces, arranged in the parabolic form, and articulated movably with each other. These five pieces are, one middle, two lateral, and two pisiform bones.

The middle (*os medium linguæ*), named also the body, is large, broad, and square, with the anterior surface in general convex and rough, divided by a middle ridge into right and left halves, and by a horizontal line into upper and lower parts, and giving attachment on each side of the middle crest to the digastric, the stylo-hyoid, the mylo-hyoid, the genio-hyoid, and the hyoglossal muscles. The posterior surface is concave and smooth, and covered by cellular tissue, connecting it to the epiglottis. To its inferior margin, which is more extensive and irregular than the superior, are attached externally the sterno-hyoid, the omo-hyoid, and the thyro-hyoid muscles; and in the middle the thyro-hyoid membrane. To its upper margin the fibres of the *hyoglossus* are attached. Each of the lateral margins is moulded into a convex cartilaginous surface, articulated with the lateral bones.

The lateral bones (*ossa lateralia, cornua*), though longer, are less thick than the body Broad and thick before, with the upper surface concave and the lower convex, narrow behind, they terminate in a round head, tipped with cartilage, to which the thyro-hyoid ligament is attached. At the anterior junction nearly of these with the middle portion, there is attached to the latter on each side a small elongated bone, somewhat hooked. These bones, which seldom exceed the size of a grain of wheat, or rye rather, and which they somewhat resemble in

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shape, are articulated to the other two by a true capsular ligament. To their outer surface are attached some fibres of the *genio-glossus*, and to their upper is fixed the stylo-hyoid ligament.

The hyoid bone consists externally of compact, and internally of cancellated tissue, the latter being most abundant in the middle piece. Though composed in the infant and young subject of five portions, the articulations are invariably obliterated by ankylosis in adult life, and they are converted into a single bone. The junction of the middle and lateral portions is effected first, and that of the pisiform bones afterwards.

The cranium in general.

The bones now described, excepting the lower jaw and hyoid, are united immovably, or by *synarthrosis*. The external shape of the cranium is that of an oblong spheroid, or an ovoid, with the small diameter before. Convex in general, it is flattened laterally in the temporal regions, and below in the base. The external surface, smooth and regular above, is marked below by muscular impressions, and penetrated by numerous holes.

The sutures.

The first objects deserving attention are the serrated lines of junction, or what are named the sutures (*suturæ*), which are in general more conspicuous externally than internally, where indeed they are effaced at an earlier period of life than on the outer surface of the scull. The sutures may be most easily understood by tracing them from the sphenoid bone, which may be regarded as the central point of the cranium.

The first line is that which passes transversely across at the junction of the sphenoid with the ethmoid and superior turbinated bones in the middle, and the frontal bone on each side. Concave in the middle, this line bends backward at each extremity, where it follows the outline of the small wings of Ingrassias. It constitutes the transverse or sphenoidal suture.

The posterior margin of the body of the sphenoid bone is marked by another transverse suture, extremely short, and uniting it with the *cuneiform* process of the occipital bone. This, which is early obliterated by the indissoluble union of the sphenoid and occipital bones, is a cartilaginous junction, afterwards ossified, and, though scarcely entitled to the epithet, is named nevertheless the *basilar suture*.

A more distinct one is found in the line between the exterior concave margin of the large wing of Ingrassias and the squamous portion of the temporal bone in the *spheno-temporal suture*. It terminates below at the glenoid fissure, forming an acute angle with a short line between the pyramid and the posterior margin of the spinous process of the sphenoid, named the *petro-sphenoidal*. Above, where it terminates on the parietal bone, a short line, between the outer margin of the large wing of Ingrassias and short spaces of the parietal and frontal bones, is distinguished as the *lateral sphenoidal* or the *spheno-parietal suture*.

This line, produced backwards between the upper margin of the temporal and the lower margin of the parietal bone, constitutes a peculiar form of junction, named the squamous suture (*sutura squamosa*), the temporal, or the temporo-parietal, in which the edge of the former bone is imbricated over that of the latter. In this mode of junction, which is confined to the superior part of the temporal bone, and in which the union of the bones is not secured by dove-tail ossification, but simple imposition, the lateral pressure is effected chiefly by the force propagated from the *zygoma* and the malar bone.

The posterior part, which is united to the posterior-inferior angle of the parietal, and the anterior-inferior margin of the occipital, presents a serrated line, with alternate indentations, which are well marked, but irregular in size. This, which occasionally presents Wormian bones, may be named the *posterior-temporal suture*. The descending portion has been distinguished by the name of *mastoid suture*. Anteriorly, in the base of the cranium, where it passes the jugular notch, the line of junction, which is cartilaginous, is termed the *petro-occipital suture*.

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The sutures now enumerated agree in being found chiefly at the lower region of the cranium, and in securing the junctions of its base. The others to be yet enumerated belong to its superior region, and agree in consolidating and securing the several arches which constitute what may be named the *vault* of the *cranium*.

From the point at which the posterior, temporal, and mastoid sutures unite, a serrated line of junction ascends on each side to the common point at which the occipital and parietal bones meet. From the angular junction formed by the two limbs of this suture, it is known under the name of *lambdoidal* (Λ, *sutura lambdoidalis*); and from its situation it is termed the occipital and occipito-parietal suture. By mutual indentations, which are always distinct, it joins firmly the parietal and occipital bones; and it is the most frequent seat of Wormian bones.

From the angle of the lambdoidal suture a similar serrated line proceeds, uniting the two parietal bones on the mesial plane, with equally distinct indentations. The mode in which this stretches between the lambdoidal and coronal sutures, bearing some remote resemblance to an arrow on the drawn bow-string, has procured it the name of the sagittal (*sutura sagittalis*). In youth and in early life these two sutures are distinct; but in advanced age they are more or less, sometimes entirely, obliterated.

In some craniums the sagittal suture is continued along the frontal bone to the nasal spine, thus parting the bone in two lateral halves. This, which constitutes the proper *frontal* or *median* suture, is the remains of the original separation of the bone.

Lastly, Between the frontal bone before, and the parietal bones behind, is seen a serrated line crossing the cranium transversely, the whole breadth between the two sphenoid bones. This, which is named the *coronal* suture, presents large indentations on each side and small ones in the middle, on the external table, and a converse arrangement on the internal.

By these sutures the bones forming the vault of the cranium are firmly secured; and each bone is made to press against the other so as to augment rather than diminish strength.

The external surface.

The external surface of the cranium may be distinguished into four regions, a superior, an inferior, and two lateral ones.

The superior region, or the vault, is bounded before and behind by the nasal and occipital protuberances, and on each side by the temporal arches. It presents, besides the coronal, sagittal, and lambdoidal sutures, the superciliary arches, the frontal, parietal, and occipital protuberances, and the parietal holes. It is covered by the epicranial muscle and its *aponeurosis*.

The inferior region or base, which may be defined from the occipital protuberance behind to the nasal spine before, is free as far as the pterygoid processes of the sphenoid bone, anterior to which it is joined to the bones of the face.

In the posterior portion are seen the occipital spine and muscular impressions, the occipital hole (*foramen magnum*), the condyloid processes, the anterior and posterior condyloid holes, and the basilar process. Laterally are the digastric groove, the mastoid, styloid, and vaginal pro

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cesses, and the stylo-mastoid hole, the glenoid cavity and fissure; the jugular hole (*foramen lacerum in basi cranii*), separated by a bony process into an internal part for the *nervus vagus* and the accessory nerve, and an external for the jugular vein; the pyramid, with the carotic canal, and the anterior lacerated hole between its extremity, the basilar process, and the sphenoid bone, closed by fibro-cartilage in the recent subject. Before these objects, and nearly in the same transverse line, are seen the anterior half of the glenoid cavity of the temporal bone, the guttural orifice of the Eustachian tube, the spinous and elliptical holes of the sphenoid (Plate XXIV. fig. 5), and the pterygoid processes.

The anterior portion presents the crest or azygos process united with the vomer and ethmoidal plate, the sphenoidal sinuses, the ethmoidal bone itself, and the nasal spine of the frontal bone; laterally, the anterior surface of the pterygoid processes, the Vidian canal, the round or superior maxillary hole, the temporal and orbitar surfaces of the large wings of the sphenoid bone, the sphenoidal fissure (*foramen lacerum*), the optic holes, and the small wings of Ingrassias; and, *lastly*, the vault and internal wall of the orbit, the former by the frontal bone, the latter by the *os planum* and lacrymal bone.

The lateral regions of the cranium are nearly of an elliptical shape. Each region may be circumscribed by a line drawn from the mastoid process backwards to the union of the temporal and mastoid sutures, then following the semicircular arch of the parietal bone, and the angular arch of the frontal to the *zygoma*, ear-hole, and mastoid process. The objects inclosed in this region are the posterior mastoid hole, the mastoid process, the ear-hole, and the *zygoma*, with a large space, defined by the elevated line extending from the posterior extremity of the *zygoma* upwards to the semicircular arch of the parietal bone, where it is obtuse, and the external angular ridge of the frontal bone, where it becomes acute. To this line, the *zygoma*, and the malar bone, the fascia of the temporal muscle is firmly attached; the muscular fibres adhere to the bone below as far as the line of the sphenoid bone, and pass downwards under the *zygoma*. The whole region, though convex in early life, becomes less so in adolescence, and in manhood and advanced age it is flattened and even hollowed.

The internal surface.

The internal surface of the cranium, lined by the *dura mater*, and marked by cerebral and vascular impressions, is distinguished into the superior region or vault, and the inferior or base.

In the former, which is a regular spheroidal concave, the chief peculiarities are, on the mesial plane, the frontal crest, the sagittal groove for the superior longitudinal sinus, pits for the granules of Pacchioni, and the inside of the sagittal suture, more distinct than the outside; laterally, the upper cerebral regions of the frontal and parietal bones, with their *fossæ*, the coronal suture, and the superior occipital fossæ.

The base is more complicated, and is generally distinguished not only into lateral halves, but into anterior, middle, and posterior regions.

On the median line from before backwards, the objects are,—the blind hole (*foramen cæcum*), for the naso-frontal vessels; the ethmoidal crest (*crista galli*), and vertical plate, with the perforated plate (*e*); the spheno-ethmoidal suture; the transverse groove and olivary process, and optic holes (1 1); the pituitary fossa (*ephippium*) (3); the posterior clinoid processes (4 4); the spheno-occipital junction; the basilar groove for the *medulla oblongata* (6); the occipital hole; and the internal occipital spine and protuberance. (Plate XXIV. fig. 6.)

Of the lateral halves, the anterior or frontal region is bounded before by an indistinct curved line, formed by the vertical with the horizontal table of the frontal bone, and behind by the sphenoidal arch. In this, which is named the *frontal fossa*, the anterior lobe of the brain is lodged; while the sphenoidal arch enters the fissure of Sylvius.

Between the sphenoidal arch before, and the posterior margin of the temporal pyramid behind, is contained a cavity shaped like a spherical segment. In this, which may be named the spheno-temporal hollow (*fossa spheno-temporalis*), the anterior part of the posterior lobe of the brain is lodged. In this cavity also are seen the sphenoidal fissure; the round or superior maxillary hole; the oval or inferior maxillary hole; the spinous or meningeal hole, with the meningeal groove; the anterior or spheno-temporal fissure (*foramen lacerum anterius basis cranii*); the inner end of the carotic canal; the pyramidal groove; and the semilunar fossa for the Gasserian ganglion. (Plate XXIV. fig. 6.)

Between the temporal pyramid and the internal occipital spine is contained the posterior or temporo-occipital hollow (*fossa temporo-occipitalis*), which is further subdivided into two cavities, the cerebral above, and the cerebellic below. From the posterior margin of the pyramid to the transverse occipital ridge, a fold of the *dura mater*, stretched horizontally, separates the temporo-occipital cavity into a superior for lodging the posterior lobe of the brain, and an inferior or cerebellic for lodging the lobes of the cerebellum. In the anterior or cerebellic division is seen the posterior surface of the pyramid, with the internal auditory hole, the orifice of the cochlear aqueduct, the groove for the lateral sinus terminating in the jugular opening, the groove of the inferior petrous sinus, and the mastoid hole and suture. The only object behind is the posterior cerebral *fossa*, traversed by the lambdoidal suture.

Developement and dimensions at different periods.

In the fœtus the cranial bones inclosed between the *pericranium* and *dura mater*, which are thick, soft, and vascular, are incomplete shells not in contact with each other, with prominent and rather thick ossific centres, from which the osseous radii diverge, and terminate in thin, ciliated margins. At birth, and for some weeks after, though ossification is far advanced, the margins of the bones are incomplete, so as to form the open spaces denominated fontanelles. Of these there are six at the period of birth; the anterior or rhomboidal between the frontal and parietal bones; the posterior or triangular between the occipital and parietal bones; two lateral anterior between the parietal, sphenoidal, and temporal bones; and two posterior lateral between the parietal, temporal, and occipital bones, both of irregular shape. At these points the motions of the brain are distinctly felt.

At the same time the bones have not yet acquired their serrated margins, so that the places of the sutures, which are not yet formed, are occupied by narrow grooves between the cranial bones. As ossification advances, however, their fimbriated margins extend, and mutually meeting, are prolonged so as to be indented into each other by alternate notches and processes. At the same time the bones acquire thickness, so that a distinct space is perceived between the external and internal surface of each. The alternate processes and notches thus acquire firmness, and are immovably dovetailed into each other. In this manner the anterior angles of the parietal bones unite with the frontal, and between the posterior ones the apex of the occipital bone is gradually mortised.

In some instances, however, where the ossific centre of the original bone appears deficient in energy, or tardy in progress, a new centre may be developed in the line of

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junction, while the bones are still much apart. Thus, between the occipital and parietal bones, or between the occipital and temporal bones, may be developed new centres, from which ossification advances, as from the principal points, towards the circumference; and by the successive deposition of bony matter, the margins begin to meet those of the primary bones. The process of mutual indentation takes place exactly in the same manner as with the primary bones; and by this means secondary bones are formed in the lines of the sutures.

The period at which the cranium is entirely ossified varies in different individuals. In general the anterior or fronto-parietal fontanelle, which is the largest, is ossified at the end of the 18th or 20th month, while the anterior and posterior lateral are closed at an earlier period. In some instances, however, between the parietal and frontal bones a small space is left till the 6th or 7th year; and in many persons the part continues depressed and tender for the greater part of life. The sutures are completed at the same time, and are always distinctly formed by the 10th or 11th year. A few years after, they become more consolidated, and, as the bones acquire thickness and density by the compactness of the external and internal tables, are firmly wedged into each other. The spheno-basilar junction generally remains soft and separable till adult age, when by its union the sphenoid and occipital bones are converted into a single piece. Some time afterwards the sphenoid is united with the ethmoid, the two parietals are converted into one, and occasionally one or both are united to the frontal bone. In advanced age many of the sutures disappear entirely, at least in one surface of the cranium, generally the internal first; and the cranium would be converted into a single bone if life were continued sufficiently long.

In shape and dimensions the cranium varies at different periods of life. After ossification is completed in the child, the prominence of the ossific points, which continue more or less conspicuous till manhood and the formation of the frontal sinuses, gives it a cubo-spheroidal shape. Its section is an oval or two hemispheroidal segments, the anterior being the smallest. At this period the parietal tuberosities and the occipital eminence are prominent, the frontal bone is vaulted, and the high open forehead communicates to the countenance an expression of beauty and simplicity which are always associated with the early and middle periods of life. In the progress of years, however, these prominences become less distinct, partly by the operation of muscular action, partly by the uniform rising and swelling of the margins of all the bones; and the anterior upper and posterior part acquires a uniform spheroidal or vaulted appearance, while the lateral regions are flattened by the action of the temporal muscle. The occipital region also below the spine is flattened, and occasionally excavated; so that while the spine is prominent and unciform, the base is excavated, and overhung by the mastoid processes and the semilunar ridges. The aged scull is thus distinguished by a general rotundity or ovoidal character, unless in the temples, which are flat and hollow; and the convex but occasionally depressed forehead indicates in some degree the transition from youth to age.

The dimensions of the cranium are estimated from its diameters, longitudinal, transverse, and vertical. The first, which extends from the *foramen cæcum* of the frontal bone, is about five inches at an average. The largest transverse diameter, which extends between the bases of the temporal pyramids, is about 4½ inches; and a smaller one between the extremities of the two small sphenoidal wings is about 3 inches and 9 lines. The longest vertical diameter, which is between the anterior margin of the occipital hole and the middle of the sagittal suture, varies from 4 inches to 4 inches and 3 lines. From these measurements it results, that the most capacious part of the scull is nearly at the union of the two anterior thirds with the posterior, viz. the level of the occipital hole and basilar groove; and that the ovoidal or oblong-spheroidal is the most general shape. The variations from this shape are found chiefly in the vault, which may be flattened, oblong, cuboidal, or conical.

Varieties.

The Asio-European may be regarded as the best and most symmetrical shape, and to this most of the European *crania* belong. According to Soemmering, the Belgic scull is the most oblong-globular, the German and Italian spherical, and the Turkish the most spherical of the European. In this country the most usual shape is the oblong-spheroidal, especially among the inhabitants of England. Among an extensive collection of sculls preserved in the Museum of the University of Edinburgh, and believed to be chiefly Parisian, the prevalent shape is the oblong-spheroidal, and the globular, or the general spherical shape, with large transverse diameter approaching to the longitudinal. From the delineations given by Sandifort (*Museum Anatomicum*, tom. ii.), the English appears most prominent in the occipital region, the French the most vertical forehead, and the Italian most elevated in the vertical region, and most prominent between the parietal tuberosities. The scull of the Swede approaches the cubo-spheroidal, and that of the Russ is distinguished chiefly for the vertical front, considerable transverse width, and large cheek-bones. The latter appear not to be peculiar to the Scotish cranium.

Of the Asiatic craniums, the Tartar has the forehead large, not much arched, the occipital region large, the nasal bones descending straight from the frontal, the upper maxillary bone slightly overhanging the lower, and the chin prominent. That of the Calmuc has the vertical, occipital, and parietal regions prominent, the frontal bone and face flattened, the cheek-bones large, and the alveolar arches and jaws broad and prominent. The Mongolian is distinguished by the narrow forehead, flattened and rather depressed glabellar and nasal regions, great facial width between the cheek-bones, and prominent upper jaw

From the observations of Blumenbach and Soemmering it results, that the ancient Egyptian or Coptic head, as exemplified in mummies, belongs to the European class of craniums. The negro head, on the contrary, is distinguished for its oblique forehead, compressed sides, prominent jaws, general wedged shape, and large size compared with the rest of the skeleton. For more minute information on these varieties, the reader will consult with advantage the work of Soemmering (tom. i.), and the *Decades Craniorum* of Blumenbach.

The face generally.

In shape the face forms an irregular hexahedron, with a large excavation at its lower region for the mouth and pharynx. Its anterior surface is trapezoidal, with the short side below; its sides trapezoidal, with the short side formed by the posterior margin of the maxillary *ramus*; and its upper surface is an oblique parallelogram.

The greatest transverse diameter is between the zygomatic angles of the cheek-bones, varying from 4½ to 5 inches; its smallest at the symphysis of the lower jaw, from 1½ to 2 or 2¼ inches; and on the extent and prominence of which depends the general oval shape of the countenance. The height, measured from the glabella to the triangular process of the lower jaw, varies from 4½ to 4 inches 9 lines.

The direction of the face varies according to the position of the lower jaw. When this is horizontal, the facial plane forms with it an angle of 60°, or deviates 30° from

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the vertical plane; and in some tribes, as the negro, this deviation is still greater. A more important character, however, is believed to be found by determining the direction of the face in relation to that of the cranium, or ascertaining what Camper denominates the *facial angle.* This he proposes to fix by drawing one line from the fronto-nasal protuberance to the spine of the upper maxillary bone,—the *facial* (*linea facialis*); another transversely between the external ear-holes; and from the latter a third line (*linea horizontalis*), drawn at right angles to meet the first. The angle thus formed by the facial and horizontal lines, which is termed the facial, indicates the comparative prominence of the cranium and face. In European heads generally it is about 80°; in the negro it is not above 70°; and in the Mongolian, which is intermediate, it is about 75°. The effect of this angle in giving the countenance intellectual expression, the nearer it approaches to the rectangle, was known to the ancients. In many of the busts of heroes it is almost 90°, and in those of divinities 100°; and as we know that this is much more rectangular than any specimen of the human scull furnishes, it may be inferred that it is imaginary.

It may be further observed, that in the infant the facial angle approaches to 90°, in consequence of the small relative developement of the face. Towards boyhood and puberty, when the face acquires greater size and prominence, it diminishes to 85° and 80° successively. (Cuvier, Bichat.)

The face is subdivided into cranial, facial, zygomatic, and palato-maxillary regions. It is unnecessary to enumerate again the objects found in these several regions; but it is requisite to consider shortly the cavities which are formed by the cranio-facial bones. They consist of the nasal cavities, the orbits, the tympanal cavity, and the palato-maxillary region. These cavities are distinguished by the following circumstances. All of them communicate mutually, and are covered by fibro-mucous membrane, also continuous. In each of them is lodged one of the organs of special sensation; and each communicates with the cranial cavity by openings, through which nerves always, and sometimes vessels, are transmitted. Lastly, these cavities may be regarded as the points by which the cutaneous surface communicates directly with the mucous membrane of the gastro-pulmonary organs.

The nasal cavities (*cavum nasale, nares*), of an irregular quadrilateral shape, consist of four regions; the upper, the lower, and two lateral. The first is bounded before by the nasal bones, behind by the sphenoidal cells, with which it communicates, and above by the cribriform plate; while its lower limit is a line uniting the inferior margins of the lateral portions of the ethmoid bone. This is parted by the vertical plate of the ethmoid bone into two halves, which are the two superior passages (*meatus superior*). The lower region is bounded below by the palato-maxillary plate; on the sides by the maxillary, palate, and inferior turbinated bones; above by a plane uniting the lower margins of these bones, and is parted into two by the vomer, which opens before at the nasal notch of the maxillary bones, and behind at the posterior margin of the palate bones. This constitutes the lower passage (*meatus inferior*), at the anterior extremity of which the nasal canal opens. The anterior part of the region presents on the mesial plane a vertical triangular notch between the middle ethmoid plate above and the *vomer* below, occupied in the recent subject by the cartilaginous *septum* of the nose. The middle and lateral regions, which communicate before by this notch, are separated behind by the ethmoid plate and vomer, and are bounded above by the ethmoidal turbinated bone, and below by the maxillary turbinated bone. This constitutes the middle canal (*meatus medius*), in which the frontal and maxillary sinuses open.

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These cavities communicate freely with each other; and their parietes are covered by continuations of the same general fibro-mucous membrane. Their use appears to be to increase the extent without adding to the weight of the facial bones, to afford great superficial extent to the nasal membrane as an organ of smell, and to afford a sonorous vault to the organ of voice.

These cavities, and their appendages, do not exist in the fœtus, nor for some time after birth. The ethmoidal and sphenoidal are early formed; and the maxillary sinus begins to be manifest some months after birth. After the primary dentition they enlarge, and rapidly after the second; and towards the approach of puberty, when the maxillary tuberosity is formed, they increase, and speedily attain their natural capacity.

The orbits are two cavities, one on each side of the mesial plane, of the shape of a quadrilateral pyramid, with the apex towards the cranial cavity, and the base anteriorly. Each orbit presents a *vault* formed by the frontal bone, a *floor* formed by the superior maxillary, an internal wall formed by the palate bone, ethmoid, and lacrymal, and an external wall formed by the malar and sphenoid bones. The two internal walls are nearly parallel,—an arrangement which renders the axes of the orbits convergent backwards, and indefinitely divergent before. The vault of the orbit is so thin, that a pointed instrument easily penetrates; and a thrust in the eye is invariably attended with severe, generally fatal, injury to the base of the brain. The base of the orbits is oblique, with the temporal margin behind the plane of the nasal, making the eye more exposed without than on the mesial side. The inner or nasal margin presents the upper orifice of the nasal canal. At the posterior extremity of the inner wall is the optic hole; at the apex is the sphenoidal fissure, which forms nearly a right angle with the spheno-maxillary fissure below; and the floor is traversed by the superior maxillary fissure and canal. The apex of the orbit is occupied by the optic nerve, the third and fourth pair, the ophthalmic branch of the fifth, and the sixth; and the origins of the six muscles of the eyeball, with interposed fat. The base is occupied by the eyeball, surrounded with the tendinous extremities of the muscles, the lacrymal gland at the external region of the vault, and the lacrymal sac in the anterior depression of the nasal margin. To its margins are attached the palpebral and the orbicular muscle. Each orbit communicates with the nasal cavities by means of the nasal duct.

The tympanal cavity, formed in the temporal bone, communicates by the Eustachian tube with the posterior part of the nasal and palato-maxillary cavities. Its further examination belongs to a subsequent head.

The palato-maxillary cavity is formed by the palatine vault above, the alveolar arches and teeth before, by the lower jaw before and laterally, and behind by the basilar process of the occipital bone and the pterygoid processes. It is very irregular in shape, and consists of two regions, the palato-maxillary proper and the pharyngeal. The principal objects deserving notice are the incisive duct in the palatine vault, for the naso-palatine nerves; the pterygo-palatine canal at its posterior angles, for the pterygo-palatine branches; and the posterior opening of the nasal cavities. The vault is covered by periosteum and mucous membrane, with the *uvula* or soft palate suspended at its posterior margin; and the space inclosed by the lower jaw contains the tongue, attached to the hyoid bone, sublingual and submaxillary glands, and is completed by membrane, muscles, and integuments.

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§ 6. *The Thoracic Extremities.*

Thoracic extremities.

The superior or thoracic extremities consist of the shoulder, the arm, the fore-arm, the wrist, and the hand.

The shoulder consists of two bones,—the *scapula* or shoulder-blade, and the clavicle or collar-bone.

The scapula.

The *scapula* is a triangular bone occupying the posterior part of the chest, having a dorsal and a costal surface, and a superior, a vertebral, and an axillary margin.

The dorsal or posterior surface (*dorsum*) is divided by a transverse elevated spine into two parts, the *fossa supraspinata* for the *supraspinatus* muscle, and the *fossa infraspinata* for the *infraspinatus* muscle. The latter is concave above, convex in the middle, and concave towards the axillary or external margin (*costa*), from which it is separated by a round line or crest for the attachment of the fascia which separates the *infraspinatus* from the *teres major* and *minor*. Between this crest and the axillary margin above is a convex surface, of a triangular shape, with the apex above, for the attachment of the *teres minor*, and below a flat quadrilateral surface for the *teres major*.

The spine is a triangular-shaped eminence, rising obliquely from the upper fourth of the dorsal surface; low at the vertebral, elevated at the axillary margin, where it terminates in a broad, flat surface, also triangular, named the *acromion* or shoulder-top. In the posterior margin of the spine may generally be distinguished two surfaces separated by a ridge. Above the ridge the *cucullaris* is fixed; below, part of the deltoid is attached; and between is a common aponeurosis. The ridge is biparted towards the *acromion*, leaving an interval covered by periosteum and integuments only. The anterior part of the acromion presents a cartilaginous facette, for articulation with the acromial end of the clavicle. To its posterior and external margin the deltoid is attached, and to its tip the acromio-coracoid ligament is fixed.

The costal or anterior surface is of a triangular shape, with the apex below, generally concave, but subdivided into smaller spaces by two or more oblique ridges, to which intermuscular *fasciæ* are attached. This surface, which is the *subscapular fossa* (*venter*), lodges the belly of the subscapular muscle, the fasciculi of which are interposed between the aponeurotic ridges. Near the vertebral margin is an irregular surface, to which, and also to the margin, the *serratus magnus* is attached.

The superior margin (*costa superior*) is thin and pointed behind, where the *levator* and omohyoid muscles are attached, and becomes sinuous externally, with a notch converted by a ligament into a hole for the transit of the suprascapular vessels and nerves. The inner or axillary extremity terminates in an elevated hooked process, the coracoid, to the tip of which are fixed the coraco-clavicular ligament, and the united origin of the short head of the *biceps flexor* and the *coraco-brachialis*, to the anterior margin the small pectoral, and to the posterior the acromio-coracoid ligament.

The vertebral or posterior margin (*costa posterior*, *basis* of some authors) is thin, and ascends straight to the spine, giving attachment to the *rhomboideus*; then bends forward, and forms with the superior an angle, to which, as also to the edge now mentioned, the *levator* is fixed.

The axillary margin (*costa axillaris*, sometimes *inferior*) is round and broad above, and narrow below. It presents above, first the glenoid cavity, round at its lower margin, angular above, hollow, covered by cartilage and synovial membrane for receiving the head of the *humerus*. At the angular point above is a surface for the attachment of the long head of the *biceps flexor*, and the lower margin presents two tubercular eminences for that of the long head of the *triceps extensor*. Below this are fixed the *teres minor*, the *subscapularis*, and the *teres major*. The *latissimus dorsi*, passing over its lower angle, binds it down.

The scapula consists chiefly of compact bone, with little cancellated matter interposed. In the subscapular *fossa* this becomes completely absorbed, rendering the bone thin and translucent, sometimes perforated. The spine, processes, and angles contain cancellated matter. It is formed from one part for the body of the bone, with *epiphyses* for the coracoid process and the margins. Nutritious holes are generally found in the angle formed by the spine with the body, and in the axillary margin.

Clavicle or collar bone.

The collar bone or clavicle is a cylindrical bone, alternately incurvated like an *ſ*, placed at the upper part of the chest, between the sternum and acromion of the scapula. It has therefore two extremities, a sternal and acromial, with intermediate body.

The *sternal* end is triangular, cartilaginous, concave and convex in opposite directions, surrounded by ligamentous insertions. The *acromial* end is flattened and recurved, presenting a lunated surface for articulation with the acromion.

The body, with the shape of a triangular prism at the sternal end, is rounded above for the attachment of the clavicular portion of the sterno-mastoid muscle, and presents below a rough surface for the costo-clavicular ligament, and a sinuated line for the subclavian muscle. Towards the acromial end, where it is flattened above and below, it presents before, a surface for the attachment of the large pectoral and deltoid muscles; behind, another for the *cucullaris*; and below, a prominent oblique crest for the coraco-clavicular ligaments.

Compact in the middle, and cancellated at its extremities, the clavicle is developed from a single point.

The arm-bone.

The arm-bone or *humerus* (*os brachii*) is a long cylindrical bone, divided into head or scapular end, cubital or lower end, and shaft or body.

The head presents three eminences, the articular head, the anterior tuberosity, and the external tuberosity. The first, which is hemispherical, incrusted by cartilage and synovial membrane, with the axis oblique to that of the bone, and articulating with the glenoid cavity of the scapula, is separated from the bone by a narrow depressed line named the neck (*collum*), in which is fixed the margin of the scapulo-humeral capsular ligament. The second is a small, pointed, sometimes bifid eminence, to which the tendon of the *subscapularis* is attached. In the external tuberosity are distinguished three facettes, to the upper of which the tendon of the *supraspinatus*, to the middle that of the *infraspinatus*, and to the posterior the tendon of the *teres minor*, are inserted. Between the anterior and the external tuberosity is a longitudinal groove named the *bicipital*, for the transit of the long head of the *biceps flexor*.

The cubital or lower extremity is flattened transversely, and moulded into different eminences and depressions. Internally is the inner or ulnar condyle, large and prominent, for the attachment of the internal lateral ligament, and a tendon common to the *pronator teres*, *palmaris longus*, *flexor sublimis*, *radialis internus*, and *ulnaris internus*. Externally is the outer or radial condyle, to which are attached the external lateral ligament, and the tendon common to the supinators and extensors, viz. *supinator longus* and *brevis*, *anconeus*, *radialis externus*, *ulnaris externus*, and *extensor communis*. Between these is an articular surface covered by cartilage, moulded into the small head which moves in the cavity of the *radius*,—a groove corresponding to the margin of the latter; the semicircular crest interposed between the *radius* and *ulna*,—

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Thoracic extremities.

another groove rather larger, in which the prominence of the sigmoid cavity is lodged; and the trochlear or pulley-like eminence, which is received in the internal part of the sigmoid cavity, and the size of which renders the inner side of the humerus larger than the outer, and gives it the oblique direction when placed on the horizontal plane. Before is a superficial pit for the coronoid process of the *ulna* during flexion of the fore-arm, and behind is a deep one for receiving the *olecranon* during extension.

The shaft is not cylindrical, but prismatic, consisting of three surfaces, bounded by an equal number of lines. The first line, which descends from the anterior tuberosity, and, winding to the side, terminates on the ulnar condyle, is anterior above, where the tendons of the *latissimus dorsi* and *teres major*, and the short head of the *triceps*, are attached, but becomes internal-lateral below, where an intermuscular aponeurosis is fixed. The second, which descends from the fore-part of the large tuberosity to the anterior articular pit, is anterior throughout, and gives attachment above to the large pectoral muscle, at the middle to the deltoid, and below to the *brachialis externus*. The third line, which descends from the back of the great tuberosity to the external or radial condyle, is posterior above, where the *triceps* is fixed, but external below, where the intermuscular aponeurosis and the *supinator longus* are attached.

Of the three surfaces, the first, which is anterior and internal, presents above, the bicipital groove, covered by periosteum and synovial membrane for the long head of the *biceps*; in the middle, the medullary hole and insertion of the *coraco-brachialis*; and below, a surface covered by part of the *brachialis internus*. The second, which is external, is covered above by the deltoid, below by the rest of the *brachialis*, and in the middle presents the deltoid tuberosity for the insertion of its tendon, and below this an oblique sinuosity traversed by the radial nerve. The third, which is posterior, gives attachment above to the *triceps*, and below is merely covered by that muscle.

The *humerus*, cancellated at its extremities, and compact in the shaft, is ossified in three parts; one for the latter, and one for each of the former.

The ulna.

The *ulna* or cubit (*cubitus*) is a long bone placed at the inside of the fore-arm, articulated above with the *humerus*, below with the *carpus* or wrist, and laterally with the *radius*. Its superior or humeral extremity consists of two eminences, and an intermediate semilunar or crescentic cavity. The first is a large head named the *olecranon* (ωλενης κρανον, *ulnæ caput*, or elbow; *processus anconeus*, *ancon*); irregular above, with a small space behind, where the tendon of the triceps extensor is fixed; concave and cartilaginous before, where it forms part of the sigmoid cavity. The second is a broad, thin-edged process, prominent before, about half an inch below the olecranon, the upper surface of which is cartilaginous, and completes the sigmoid cavity; the lower surface is rough for the *brachialis internus*, some fibres of the *pronator teres*, the *flexor sublimis*, and the internal ligament of the humero-cubital articulation. At the outside, and continuous with the sigmoid cavity, is a small semicircular cartilaginous surface—the *small semilunar*—for articulating with he head of the *radius*.

The lower or carpal extremity presents a cartilaginous surface, shaped like a circular sector, the circular margin being bent upwards, so as to form a circular surface for the inner articular surface of the *radius*, while from the centre of its radii arises a pointed process named the styloid, to the tip of which the external ligament of the radio-carpal articulation is fixed. Between the styloid process and sectorial surface is a depression, to which is fixed the fibro-cartilage of the joint; and behind and without the styloid process is a longitudinal groove for the motion of the tendon of the *ulnaris externus*.

The shaft has the shape of a trilateral prism, except at the lower extremity, where it becomes cylindrical. Of the three lines by which the surfaces are bounded, the external or radial, which is strongly marked, and sharp at the middle, extends from the posterior tip of the small sigmoid cavity to about two inches above the lower end, and gives attachment to the interosseous ligament. The second, internal or ulnar, which is obtuse, descends from the inner edge of the coronoid process to the inside of the styloid, and gives attachment above and in the middle to the *flexor profundus*, and below to the *pronator quadratus*. The third, posterior, obtuse above and below, sharp in the middle, extends from the olecranon to the outside of the styloid process, and gives attachment to an aponeurosis.

Of the surfaces inclosed by these lines, to the anterior, which is concave, and contains the medullary hole, the *flexor sublimis* is attached above, and the *pronator quadratus* below. The inner is covered above, where it is broad, by the *flexor profundus*, and below by the integuments. The posterior or radial is parted by a line into two spaces, to the larger of which are fixed the *anconeus* and *ulnaris externus*, and to the smaller the *supinator brevis*, *extensores pollicis longus et brevis*, the *abductor pollicis*, and *extensor indicis*.

The radius.

The *radius* is a long bone, rather shorter than the *ulna*, forming the outer bone of the fore-arm, articulated above with the *humerus*, below with the carpus, and at the inside with the *ulna*.

The upper extremity consists of a circular cartilaginous head, concave for receiving the small head of the *humerus*, with a cartilaginous surface on its inner or ulnar side for articulating with the small sigmoid cavity of the ulna, and a rough one for the annular ligament on the outside. Below this the bone is contracted and forms the neck of the radius, and again swells before into a large rough prominent tubercle, to which the tendon of the *biceps flexor* is fixed, and which is therefore named the *bicipital tuberosity*.

The lower extremity, which is double the size, forms an extensive surface for articulation with the scaphoid and semilunar bones of the *carpus*, continuous on the ulnar side with a small cartilaginous surface for articulation with that of the *ulna*, bounded without by the styloid process, a rough triangular eminence, to which is fixed the external ligament, and bounded elsewhere by a rough margin for ligamentous insertions. The posterior part of this end presents two eminences inclosing a wide hollow, separated by a small eminence into two grooves,—an inner or ulnar, large for the tendons of the *extensor communis* and the *extensor proprius indicis*, and an outer or radial for the *extensor longus pollicis*. Between the middle eminence and the styloid process are two other grooves,—the anterior for the *abductor magnus* and the *extensor brevis* of the thumb, and the posterior for those of the *radiales externi*.

The shaft or body, which is thin and round above, prismatic in the middle and below, presents three surfaces inclosed by an equal number of lines. Of the latter, the inner or ulnar descends from the inner margin of the bicipital tuberosity, sharp and prominent, to the small inner articular surface, and gives attachment to the interosseous ligament. To the outer, which descends from the outer margin of the tuberosity, obtuse, to the base of the styloid process, the *flexor sublimis*, *pronator quadratus*, and *supinator longus* are attached. The third, also obtuse, is indistinct to the second third of the bone,

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whence it proceeds to the middle tubercle of the carpal extremity.

The anterior surface, which is hollow above, presents the medullary hole and the attachment of the *flexor longus pollicis* below that of the *pronator quadratus*. The posterior, hollowed in the middle, corresponds to the *supinator brevis*, the extensors, and *abductor pollicis*, which are attached to it; and the common extensors, *extensor proprius indicis*, and *extensor pollicis*, by which it is simply covered. The external surface, which is rounded, is covered above by the *supinator brevis*, in the middle by the *pronator teres*, which are attached to it; and below by the radial extensors (*radiales externi*), which merely glide over it.

The *ulna* and *radius* consist of cancellated structure in the *epiphyses*, and compact inclosing cancelli in the *diaphyses*, and are each ossified in three points.

These two bones are mutually connected by a broad web of periosteum continued from that of the bones, and named the *interosseous* ligament, the principal use of which is to enable the radius to roll laterally in the motions of pronation and supination on the *ulna*, and to give attachment to muscles without adding to the weight of the fore-arm by intermediate bone.

The bones of the hand consist of those of the *carpus*, the *metacarpus*, and the *phalanges*.

The carpal bones.

The *carpus* consists of eight short and irregular-shaped bones, arranged in two rows. Those of the first are the scaphoid or navicular (*os scaphoides, os naviculare*), the semilunar (*os lunatum*), the cuneiform or trilateral (*os triquetrum*), and the pisiform or lenticular (*os orbiculare, os pisiforme*). Those of the second row are the trapezal (*trapezium*), the trapezoidal (*os trapezoides*), the large bone (*os magnum, os capitatum*), and the unciform bone (*os unciforme, os hamatum*).

Of these bones, which it would be tedious to describe minutely, it is enough to say, that their names are intended to indicate their shape; that they are connected mutually by cartilaginous surfaces, so as to allow the gliding motion only; and that, besides periosteum, they are invested by ligaments which maintain them in their position, and tend to strengthen and consolidate the wrist, as the basis of support for the hand and fingers.

By the upper articular surface of the scaphoid and semilunar bones, the *carpus* is connected to the lower extremity of the *radius;* while the upper surface of the trilateral bone is contiguous to the fibro-cartilage of the radio-carpal articulation, and the upper surface of which is in contact with the lower articular surface of the *ulna*. The pisiform bone, which is attached to the anterior surface of the latter, and thus projects before the plane of the other bones into the hand, may be regarded as a sesamoid bone, which serves as a point of insertion to the tendons of the *flexor carpi ulnaris* above, the fibres of the *adductor* of the little finger below, and those of the anterior carpal ligament before.

The inferior surface of the navicular bone is articulated at once to the superior surfaces of the *trapezium* and *trapezoides*. The palmar or anterior surface of the former presents a small groove, in which moves the tendon of the *flexor carpi radialis*, bounded on the outside by the pyramidal process, to which the annular ligament is attached. The *os magnum*, which is articulated above with the semilunar bone, on the radial side with the scaphoid and trapezoidal, below with two metacarpal bones, and on the ulnar side with the unciform bone, is thus wedged firmly like a central base between the others, and contributes much to the solidity of the carpal articulations. The unciform, which is placed at the inside of the range, and is articulated above with the lunar and cuneiform, laterally with the scaphoid, and below with the two inner metacarpal bones, is distinguished by the unciform process rising from its palmar surface, to which part of the *abductor* and *flexor brevis minimi digiti* and the annular ligament are attached, and which, stretched between this and the pyramidal process of the *trapezium*, form a species of arch over the flexor tendons.

The carpal bones consist of cancellated tissue, invested by a thin pellicle of compact bone. In the fœtus and infant they are composed chiefly of brown-coloured, callous substance, homogeneous, but without the smallest trace of bone. Their penetration with this substance takes place about eighteen months or two years after birth.

The metacarpal bones.

The *metacarpus* is usually said to consist of five bones. This is correct so far as situation goes; but one of these bears little resemblance either in shape, connection, or purpose with the other four. It appears, therefore, more natural to restrict the name of *metacarpal* to the four bones which support the digital phalanges, than to extend it to the thumb, the first bone of which is to be regarded as a *phalanx* only.

The four metacarpal bones agree in having trapezoidal heads, cylindrical bodies with an elevated longitudinal line before, and rounded convex lower ends for moving on the concave articular surfaces of the phalanges.

Besides the upper trapezoidal surfaces for articulating with the trapezoidal, large, and unciform bones, the lateral margins are provided with facettes, the first and fourth on one side only, the mutual, the second and third, on both, for articulation with each other. In this manner the metacarpal bone of the index finger is articulated above to the trapezoidal and large bone, and on the inside to the metacarpal bone of the middle finger; the latter is articulated above to the large bone, and on the one side to the index metacarpal bone, on the other to that of the ring finger; while the latter and the metacarpal bone of the little finger are articulated above to the unciform bone and to each other.

The bodies of the metacarpal bones are slightly incurvated before, and form a hollow which corresponds with the palm. In their intervals are contained the *interossei* muscles, the internal at the volar, the external at the dorsal surface. The anterior surface is covered by the flexor tendons, the *lumbricales*, and the palmar fascia. The dorsal surface, which is convex in general, is covered by the extensor tendons.

The index metacarpal bone has attached to its radial margin the first dorsal *interosseus*, to its ulnar, before, the first palmar *interosseus*, and behind the second dorsal *interosseus;* while to its upper anterior extremity the *radialis internus* is inserted, and to the same extremity behind the *extensor radialis longior*.

To the second or middle metacarpal bone, besides the palmar *fascia* and the second and third *interossei*, the *adductor pollicis* and *flexor brevis* are attached to the palmar surface; and the *extensor radialis brevior* is inserted into its dorsal surface.

The fourth or small metacarpal bone, besides the palmar fascia and the third palmar and fourth dorsal *interosseus*, gives insertion by its dorsal surface to the *extensor carpi ulnaris*.

The *phalanges* or bones of the fingers are fifteen small longitudinal bones placed vertically on each other, three to each finger; or forming ranges distinguished into metacarpal, middle, and unguinal, the first row being the longest, the second shorter, and the third or unguinal the shortest.

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The phalanges.

The metacarpal *phalanges* agree in having the upper extremities shaped like rounded cubes, with concave cartilaginous surfaces for receiving the lower extremities of the metacarpal bones, and tubercular sides for the attachment of the lateral ligaments. The upper ends of the middle and unguinal are moulded into two cartilaginous cavities with an intermediate ridge, with lateral tubercles for the lateral ligaments. The lower extremities of the metacarpal and middle *phalanges*, which are smaller than the upper, are rounded and separated by a small groove into two condyles, which are received into the cavities of the upper ends. The lower extremities of the unguinal phalanges, which terminate the fingers, are flattened antero-posteriorly, and moulded into crescentic tips (*lunulæ*) transversely.

The bodies of the metacarpal and middle phalanges are convex behind, and have a surface flat before, bounded on each side by a sharp marginal line, and taper gradually from above downwards. Those of the unguinal phalanges, excepting that of the thumb, are convex before as well as behind. The palmar surface of the metacarpal phalanges is covered by the flexor tendons, which in the superficial muscle are inserted into the anterior and upper part of the middle phalanx, while those of the deep-seated flexor are inserted into the upper anterior part of the unguinal phalanx. The first phalanx of the thumb, which is generally considered as a metacarpal bone, has the *abductor magnus* inserted into its upper extremity, and the *opponens* and *flexor brevis* into its body. The dorsal surfaces are covered by the extensor tendons, which, with those of the *lumbricales* and *interossei*, are inserted into the middle phalanges.

The metacarpal and phalangeal bones are compact, with cancellated extremities, and are ossified in three points.

Connections. Shoulder-joint.

The bones now enumerated are connected so as to admit of motion to various extents. The *humerus*, articulated with the glenoid cavity of the *scapula* by a capsular ligament, while the long head of the *biceps* serves the purpose of a round ligament, admits of motion in every direction,—flexion, extension, abduction, adduction, circumduction, and rotation. The humero-cubital articulation, which is secured by two lateral ligaments, admits of extension and flexion only; but in any position of the *ulna* in relation to the humerus, the *radius* rolls on the former, so as to produce those motions of the wrist and hand which are denominated *pronation* or *internal rotation*, and *supination* or *external rotation*.

Elbow-joint.

Wrist and finger joints.

The carpal bones are articulated chiefly with the *radius*, so as to admit of flexion and extension, adduction and abduction, and even some degree of circumduction and rotation. The metacarpal bones are limited in motion. The metacarpal phalanges admit of flexion and extension, abduction and adduction, circumduction and rotation; while those of the middle and unguinal range are confined to flexion and extension. The precision, nevertheless, of which these motions are susceptible, with the numerous modifications which they undergo in combination with the opposable powers of the thumb, and the nicety and delicacy of tact inherent in the skin of the fingers, are the means from which the human hand derives its remarkable aptitude for all the mechanical arts, and all operations requiring manual dexterity. By the combination almost endless of a number of simple motions, so many complex motions are produced, that it is difficult to set limits to the degree of perfection which the hand and fingers, as an organ of prehension, may attain.

The bones of the pelvic extremities.

§ 7. *The Bones of the Pelvic Extremities.*

The bones proper to the lower or pelvic extremities are, the thigh-bone (*femur*), the shin-bone (*tibia*), and leg-bone (*fibula*); with the knee-pan (*rotula, patella*), seven tarsal bones, four metatarsal bones, and 15 phalanges.

The thigh-bone.

The thigh-bone (*femur, os femoris*) is the largest, thickest, strongest, and heaviest bone of the skeleton.

The upper or iliac extremity consists of a head, neck, and two tuberosities named *trochanters*. The head is globular, incrusted by cartilage and synovial membrane, unless at its internal point, where there is an irregular depression for the insertion of the round ligament, and is lodged in the cotyloid cavity (*acetabulum*). It is situate internally in relation to the shaft; and its axis, which forms with that of the latter an obtuse angle, variable in extent according to age and sex, is represented by that of the neck, a contracted cylinder of bone, varying in length according to the same circumstances, flattened before and behind, presenting numerous vascular holes, and covered by fibrous slips and synovial membrane. The junction of the neck with the bone is marked by a large prominent body named the *trochanter major* (T), in which four surfaces may be recognised; an external lateral, for the insertion of the *glutæus medius*, and the motion of the tendon of the *glutæus maximus*; an internal with a pit, for the insertion of the tendon of the *pyriformis*, of the *gemelli*, and of the obturators; an anterior for the insertion of the tendon of the *glutæus minimus*; and a posterior for that of the *quadratus femoris*. At the union of the neck with the *diaphysis* below, and externally, is a conical eminence named the small *trochanter* (t), to which the united tendon of the *psoas magnus* and *iliacus internus* is fixed. The spaces between the trochanters before and behind are united by oblique rough lines, to which the femoral margin of the capsular ligament is attached, and the entire space within which is continuous with the articular cavity.

The lower or tibial extremity, which is large, is moulded into two rounded eminences named condyles (κονδυλοι) (1, 2; a, b); the one internal, deeper, and larger than the external, separated by an antero-posterior depression (*fossa intercondyloris*), and prominent and convex behind. Each condyle has an external and internal surface, while the articular one, which is incrusted by cartilage and synovial membrane, is shaped something like a horse-shoe, incurvated upwards in the middle before, and behind on each side, with elevated irregular margins for the attachment of the articular capsule. The intercondylar depression before receives the upper part of the knee-pan (*patella*), while in the intercondylar cavity behind are lodged the fimbriated margins of the synovial membrane, with the femoral ends of the cross ligaments, the anterior of which is inserted into the inner surface of the external condyle, and the posterior into that of the internal condyle. The outer or fibular surface of the external condyle presents an eminence for the attachment of the external lateral ligament, and a depression below for that of the *poplitæus*. The outer or tibial surface of the internal condyle has a prominent tubercle, to which are fixed the internal lateral ligament and the tendon of the *adductor magnus*. In a pit above each condyle the heads of the *gemellus* (*gastrocnemius externus*) are fixed.

The shaft or body, which approaches the cylindrical shape, is incurvated, with the convexity before, and the concavity behind (F, f). The anterior surface is uniformly round, and covered by the *cruræus*, which is fixed above to the interval between the trochanters. The posterior surface presents a rough elevated line, descending from the base of the large trochanter, meeting a similar line descending from the small trochanter, and inclosing a triangular rough space, forming about the middle third of the bone a rough elevated line (*linea aspera*) (l), which again is parted into two, less distinct; one termi-

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The *femur*, which is one of the most perfect examples of a long cylindrical bone, is compact in the *diaphysis*, with distinct medullary canal, and cancellated in the *epiphyses*. It is ossified in four portions; one for the *diaphysis* and neck, one for the two condyles, one for the head, and in general one for the *trochanter major*. The neck, which is short in early life, becomes long in adult age, and the body acquires its peculiar incurvation apparently from muscular action. In the female this incurvation is greater than in the male, and the neck forms a greater angle with the body.

The knee-pan. The knee-pan (*rotula, patella*) (P) is a short bone, shaped like a heart, with the apex downward, convex and fibrous before, where it is covered by tendinous matter; flat above, where the *rectus*, the two *vasti*, and the *cruræus*, are inserted; plane and concave behind, where it is covered by cartilage and synovial membrane, and separated into two unequal divisions by a middle ridge, forming the anterior wall of the knee-joint, and applied by its superior half over the anterior intercondylar *fossa*. The lower apex is rough for the attachment of the inferior ligament; and to the margins are fixed those of the fibro-tendinous capsular, by which it is connected to the *femur* and *tibia*.

The knee-pan, which has a peculiar cancellated structure, invested by a thin plate of compact bone, is to be regarded partly as a sesamoid bone for the insertion of the common tendon of the four extensors of the leg, partly as an appendage or *epiphysis* to the superior part of the *tibia*, performing to that bone the same function which the *olecranon* does to the *ulna*.

The shin-bone. The *tibia* is a prismatic-shaped long bone, situate at the inner and anterior region of the leg, with the femoral condyles above, the *astragalus* below, and the *fibula* on the external side.

The head, upper or femoral end, is large, and of an irregular oval shape. It presents two slightly concave elliptical cartilaginous surfaces, with the long diameter antero-posterior, separated by a rough vascular space, large before and narrow behind. Of these elliptical surfaces the external margin is most regular, and presents a crescentic or lunated mark for the attachment of the semilunar fibro-cartilages, which thus increase the concavity of the articular surfaces for the reception of the condyles. The inner or mesial margin of each is elevated into a curved peak, mutually separated by a depression. These eminences, which are jointly named the *spine* of the *tibia*, correspond in flexion and extension to the intercondylar *fossa*. Before is a triarcual surface, rough for the insertion of the anterior crucial ligament, and behind a notch for that of the posterior. The lateral circumference of the head, which is rough, and marked by vascular holes, presents before a triangular surface, the upper half of which corresponds to the inner surface of the knee-pan, and is contained within the cavity of the joint; while the lower angular portion is convex for the insertion of the inferior patellar ligament, or the last insertion of the tendon of the *rectus* and *vastus externus*. The sides, which are rounded and prominent, are named respectively the *external* and *internal tuberosities*, and give attachment to the external and internal lateral ligaments. To the back part of the internal also the tendon of the *semimembranosus* is fixed (d), while that of the external presents a cartilaginous facette for the articulation of the head of the *fibula* (c).

The lower or tarsal extremity, which is much smaller, is nearly quadrilateral, with a cartilaginous surface concave transversely, with elevated anterior and posterior borders, and the internal raised into a vertical eminence named the inner ankle (*malleolus internus*) (f), to the apex of which the internal lateral ligament is fixed. This cartilaginous surface, which receives the head of the *astragalus*, is surrounded by a furrow, very distinct before, in which ligamentous fibres are inserted; while the external margin, which is broader than the internal, presents between two prominences a trilateral hollow, in which the tarsal end of the *fibula* is lodged. The anterior surface is covered by the tendons of the *tibialis anticus* and *extensor proprius hallucis;* and the posterior, behind the internal ankle, is marked by a groove for the *tibialis posticus* and *flexor longus digitorum*, and another for the *flexor longus hallucis*.

The *body* or *diaphysis*, which is thick above, is prismatic, and presents three surfaces, bounded by the same number of lines. The first, which is anterior (*crista*), descends sharp and prominent from the anterior margin of the external tuberosity to the fore part of the internal ankle, and, though subcutaneous, gives attachment to the tibial aponeurosis and the *tibialis anticus*. To the external, which is sharp, and descends from the posterior margin of the same tuberosity to the anterior tubercle of the lower end, the interosseous ligament is fixed. To the internal, which is obtuse, and rather rounded, and descends from the posterior part of the internal tuberosity to that of the inner ankle, the *poplitæus* above, and the second or inner head of the *solæus*, with the *flexor longus digitorum*, are attached.

The surfaces bounded by these lines are *internal*, *external*, and *posterior*. The first, which is convex, gives insertion above to the *sartorius*, *gracilis*, and *semitendinosus*, and is elsewhere covered by integuments only. The external is concave above, where the *tibialis anticus* is fixed; convex below, where it is covered by the tendons of this muscle, and of the *extensor communis* and *proprius*. The posterior is crossed by an oblique line (T, 1, Plate XXV.) descending from the fibular articular surface to the internal line, and forming two spaces, the superior of which, triangular, is covered by the *poplitæus* inserted into the oblique line, while the lower, occupied by the *tibialis posticus* and *flexor longus*, presents also the medullary holes.

The *tibia*, compact in the *diaphysis*, with medullary canal, cancellated in the *epiphyses*, is ossified in three portions, one for the former part, and one for each of the latter.

The leg-bone. The *fibula*, which is the most slender bone of the skeleton of equal length, is situate at the outer side of the *tibia*, with its lower extremity anterior to the plane of the upper, articulated above with the latter bone only, below with the *tibia* and *astragalus* at once.

The head or tibial end, which is of an irregular cuboidal shape, presents above an oblique, trilateral, cartilaginous surface, articulated with that behind the external tibial tuberosity, by which also it is overhung. Before is a triangular surface, slightly convex, for part of the femoro-tibial ligament; behind, a tubercular surface for ligamentous insertions; and externally, between the two, is an extensive pentagonal surface for the insertion of the

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bicipital tendon, terminating above in an angular point, to which is fixed the peroneo-tibial ligament.

The lower or tarsal end consists of a pointed trilateral pyramid, the external surface of which, somewhat convex, is subcutaneous, and forms the external or fibular ankle (*malleolus externus*) (e). Within is a trapezoidal cartilaginous surface, which is articulated with the *astragalus;* and behind and below is a rough triangular surface, with a cavity for the insertion of the fibulo-tarsal ligament, while the external ligament is fixed to its angular tip. The posterior surface presents a groove, sometimes two, incrusted by fibro-cartilage for the motion of the *peronæi longus et brevis.*

The body is marked by several lines inclosing surfaces rather irregular in shape and extent. Among the former the following may be recognised:—An anterior, commencing about $2\frac{1}{2}$ inches below the head, distinct in the middle, where the *aponeurosis* common to the *extensor longus digitorum* and *peronæus tertius* before, and the *peronæus longus et brevis* behind, is attached, and bifurcating about $2\frac{1}{2}$ inches above the lower end into an anterior and posterior, terminating on the anterior and posterior margins respectively of the *malleolus externus,* inclosing a triangular space, which is covered by integuments only. The internal, descending from about an inch below the head to the anterior edge of the internal *malleolus,* coincides there with the anterior part of the anterior line. To this, above and in the middle, the *tibialis posticus* and *flexor proprius pollicis,* and below the interosseous ligament, are attached. The external or posterior descends from the posterior part of the head, obtuse, and winds round below to the posterior part of the tarsal end, giving attachment to an *aponeurosis* intermediate between the lateral *peronæi* without, and the *flexor proprius* and *solæus* behind. Between the external and the anterior is an oblique line, to which the interosseous ligament is fixed.

The external surface between the anterior and posterior lines, narrow above, convex and broad in the middle, and winding spirally round the axis of the bone, is covered by the *peronæus longus* and *brevis.* An anterior, plane, is covered by the *extensor longus* and *peronæus tertius.* The internal or tibial is divided by the oblique line into two; an anterior for the *extensor proprius,* and a posterior for the *tibialis posticus.* To the posterior surface above, which is convex, the *solæus* is attached; and in the middle and below the *flexor longus pollicis;* while, by the rough triangular surface below, the bone is articulated with the trilateral cavity of the *tibia.*

The *fibula,* which is ossified in three portions, partakes of the general characters of structure common to the long bones.

The tarsus. The *tarsus* consists of seven short irregular-shaped bones, the *astragalus,* the heel-bone (*calcaneum, os calcis*), the scaphoid, cuboid, and three cuneiform bones.

The first (*talus, astragalus*) has a convex cartilaginous surface above for articulation with the lower end of the *tibia,* continuous with a similar trilateral concave surface on the inside for articulating with the malleolar process, and with a smaller triarcual surface on the outside for the fibula; two cartilaginous surfaces, separated by a deep pit below, for articulating with the *calcaneum;* and an anterior eminence, with a convex cartilaginous surface, for articulating with the scaphoid bone before. The *calcaneum,* which is the largest, consists of the posterior tuberosity (*talus*) (c), for the insertion of the united tendons of the *gastrocnemius* and *solæus,* and that of the *plantaris;* two upper cartilaginous surfaces, separated by a ligamentous pit, for articulating with the *astragalus;* an anterior cartilaginous trilateral surface for the cuboid bone; an internal lateral sinuosity for the passage of the flexor tendons, that of the *tibialis posticus,* and the posterior tibial artery and nerves; and, lastly, an external lateral surface, covered by integuments and the tendons of the lateral *peronæi.*

The scaphoid bone is connected by its posterior concave surface with the anterior convex one of the *astragalus,* and presents before a cartilaginous surface with three facettes for the three cuneiform bones, and on the outside a small facette for the cuboid. On the inside is a prominent tuberosity for the attachment of the *tibialis posticus.* The cuboid bone, which constitutes the outer margin of the tarsus, and is articulated with the trilateral surface of the *calcaneum,* and by a minute facette with the scaphoid bone, is chiefly distinguished by an oblique or diagonal groove, for the tendon of the *peronæus longus.* The third and fourth metatarsal bones are articulated to its anterior surface.

The three cuneiform bones agree in having posterior cartilaginous surfaces for articulation with the scaphoid bone, and anterior ones for that with the first phalanx of the great toe, and the metatarsal bones of the second and third toes. The internal surface of the large cuneiform bone is convex, covered by integuments; the external or fibular cartilaginous, with two facettes for articulation with the second cuboid bone and the first metatarsal. Its lower surface is irregular for the insertion of the *tibialis anticus,* and part of the *tibialis posticus.* The second cuneiform bone, which is the smallest of the three, and the most like its name, is wedged between the scaphoid behind, the first and third on each side, and supports the first metatarsal bone before. The third, which also is not unlike its denomination, is wedged between the scaphoid behind, and the second cuneiform and the cuboid bone, and sustains the second metatarsal bone; while the third and fourth are articulated with the anterior surface of the cuboid.

The metatarsal bones. Of the metatarsal bones there are four; the first three similar to each other; the fourth, which sustains the phalanges of the small toe, distinguished by a large oblique angular head for the insertion of the tendon of the *peronæus brevis,* while that of the *peronæus tertius* is fixed above. Of the other three the heads are trilateral or wedge-shaped with the base upwards, with cartilaginous facettes on the sides for mutual articulation. The bodies are cylindrical, and, tapering, terminate in round heads flattened laterally. The dorsal or upper surface is covered by the extensor tendons, the *extensor brevis digitorum,* and the dorsal vessels and nerves derived from the anterior tibial artery and nerve. The surface of these bones is so constructed that it forms an arched or convex inclined plane, descending from the tibial to the fibular side of the foot. In the anterior or plantar surface, which is concave, are lodged the *abductor hallucis, abductor minimi digiti, flexor brevis,* the flexor tendons, the accessory flexor, the *lumbricales pedis, flexor brevis hallucis, abductor hallucis, flexor brevis minimi digiti, transversalis,* and the external and internal ranges of the *interossei.*

The phalanges. The *phalanges* of the toes, in number 15, bear a general resemblance to those of the fingers; but are considerably shorter, unless in the instance of the great toe. Like these also, they are disposed in three ranges,—metatarsal, middle, and unguinal.

The pelvic extremities in general. The hip-joint. The bones now described are united so as to admit of different degrees and forms of motion. The head of the *femur,* lodged in the *acetabulum,* is retained in that cavity not only by the capsular and round ligaments, but by the numerous strong muscles with which the hip-joint is surrounded. The length of the neck, which is peculiar to the human subject, throws the supporting column of

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the bone to a greater distance, not only from the pelvis, but from the mesial plane and centre of gravity; and this character, with the great proportional length of the bone, and the extent and direction of the pelvis, constitutes the most decisive argument in favour of the doctrine, that man must support himself in the erect position on the two pelvic extremities. In most quadrupeds the neck of the *femur* is short; the cylinder is shorter than the *tibia*, and not arched; and the *pelvis*, both by its vertical direction and peculiar dimensions, is calculated for the quadruped motion only. The femur admits of motion in every direction,—flexion, extension, adduction, abduction, circumduction, and rotation.

The knee-joint.

The *tibia*, with its appendage the knee-pan, is articulated to the condyles of the *femur* by means of an external and internal lateral ligament, strengthened by an anterior or patellar ligament, posterior fibres, and an anterior and posterior cross ligament, contained within the synovial membrane. The effect of this arrangement, with the anatomical configuration of the articular ends, is to allow cardinal opposition, or flexion and extension only. A small degree of rotation, nevertheless, may be effected.

The *fibula* is articulated to the *tibia* above by a genuine capsular joint, and below by fibrous matter, and connected at its internal side by a duplicature of periosteum forming the interosseous ligament. These connections admit of little motion, and the chief use of the *fibula* is to give attachment to several muscles which bend or evert the foot. The chief weight of the person, divided as it is between each lower extremity, is communicated from the *pelvis* to the *femur*, thence to the *tibia*, and finally to the *astragalus* and *calcaneum* behind, and the metatarsal bones before. The motion of opposition is confined to the former, which rolls backwards and forwards in the cavity formed by the lower extremity of the *tibia* and the *fibula* in the flexion and extension of the foot. In this, therefore, which forms the ankle-joint, all the motions of the foot as a whole are executed. It appears further to be susceptible of a slight degree of lateral rotation, so as to contribute to the eversion and inversion of the foot.

The ankle-joint.

The tarsal bones are mutually connected by cartilaginous surfaces, and secured by numerous fibrous bands, so as to admit of the gliding motion only. This motion is further between each individual articulation very limited, and its general amount is inconsiderable. The great use of the tarsal articulations is evidently stability and solidity as a base of support, not mobility.

The arches of the foot.

The bones of the foot form two distinct and separate arches,—an antero-posterior and a transverse. The first is constituted by the posterior part of the heel-bone behind and the metatarso-phalangeal articulations before; and its chief use is to distribute the weight of the extremity from the *astragalus*, which may be regarded as the centre, to the *os calcis* and extremities of the metatarsal bones on each side. In standing, for example, either on one foot or both, the weight of each extremity is distributed before to the metatarso-phalangeal joints, and behind to the tuberosity of the *os calcis*, while the anterior part of the latter bone and the whole second range of tarsal bones do not touch the ground. The second arch results first from the arrangement of the cuneiform bones with the scaphoid, and that of the cuboid with the *os calcis*; and next from the arrangement of the metatarsal bones. These arches, which are indistinct in early life, become conspicuous as the bones are completed, and acquire their complete developement in adult age. These arches are of great use in the alternate elevation of each half of the person in progression, in ascending an inclined plane or a series of steps, and especially in springing and leaping

The *phalanges* are articulated with the metatarsal bones and with each other, so as to admit of flexion and extension chiefly, with a very limited extent of abduction and adduction. The articulation of the great toe, also destitute of the power of opposition, abridges much its extent of motion. While these circumstances, with the great brevity of the phalanges, render the foot much less perfect than the hand as an organ of prehension, they extend its sphere of support, and enlarge its powers as a locomotive agent.

Parallel between the thoracic and pelvic extremities.

The pelvic and thoracic extremities present several points of resemblance which have been well traced by Soemmering. The head, neck, and tuberosities of the *humerus* resemble the head, neck, and trochanters of the *femur*; and if the lower end of the former bone is articulated both with the *ulna* and *radius*, while that of the latter is connected to the *tibia* only, there is still sufficient analogy between the lower ends of both bones. The *tibia* resembles the *ulna* above, with the knee-pan corresponding to the olecranon; but the lower extremity of the *tibia* is represented by that of the *radius*, in consequence of the extensive connection of the latter bone with the *carpus* for the purpose of pronation and supination. The navicular and lunar bones of the carpus are represented by the single *astragalus*,—an arrangement which appears to be allied in the latter case to the purpose of stability and solidity. The *calcaneum* may be regarded as an enlarged *os magnum*, fitted for the same purpose; and even in the shape and position of the scaphoid bone the same object may be recognised. This comparison, however, it is superfluous to pursue farther. The general conclusion is, that the thoracic extremities are intended to combine with strength great extent and precision of motion, while the purpose of the pelvic is stability, solidity, and strength.

SECT. II.—MYOLOGY; THE ANATOMY OF THE MUSCLES.

The muscles.

The muscles, with their appendages the fasciæ, tendons, and synovial sheaths, constitute the second division of the locomotive organs. By the term muscle, indeed, in Special Anatomy, is meant not only a mass of flesh adequate to effect motion, but an organ consisting of *fascia*, muscular flesh, and tendon, connected by the first and last substances to the parts, fixed or movable, to be approximated. While the middle portion is denominated belly (*venter*), the two extremities are most properly named *attachments*; though by others they have been termed respectively head or origin (*caput*, *origo*), and insertion (*insitio*) or termination (*finis*), according as the one or the other end has been imagined to be most fixed.

By the contraction of the middle portion or belly the two extremities are approximated; and according as the one is connected with a bone or soft part more movable than the other, that movable portion is approximated to the fixed. This, which is the general effect of muscular action, is well exemplified in the primary bones of the extremities, the muscles of which have their fixed end in general in the trunk, and their movable end attached to the bones of the extremities. Thus in the case of the *pectoralis major* (P), Plate XXVII., and *latissimus dorsi* (L, L), Plate XXVIII., the fixed ends are in the trunk, and the movable or insertions are in the *humerus*; and the effect of the contraction of the belly is to carry the *humerus* forward over the chest in the one case, and backward on the trunk in the other. This is easily applied to other muscles. as to those of the face.

The converse of this arrangement nevertheless may take place. The extremity, which in ordinary circumstances is the most movable, may be converted into the

fixed; while that which is fixed becomes movable. Thus, in the case of the two muscles already mentioned, the *humerus* may become the fixed point; and the effect will be to elevate and approximate the trunk to the part to which the extremity is fixed.

Though all the muscles are agents of motion, all are not of locomotion; and it is chiefly the muscles connected by both ends with the skeleton, and especially those of the extremities, which are entitled to this distinction. The muscles of the face are connected always by one end, often by both, with the skin, and hence are cutaneous muscles. Those of the lower jaw and pharynx are organs of motion simply to move the parts with which they are connected in the acts of mastication and deglutition. Those of the larynx are of two orders, the *common* or *extrinsic*, connected to some of the bones of the head and chest; and the *proper* or *intrinsic*, pertaining to the laryngeal cartilages only. Those of the eye and ear, external and internal, are equally unconnected with the locomotive faculty.

These circumstances have induced several authors, especially the ancient anatomists, and among the moderns Winslow, to arrange the muscles according to the parts which they move. By others, however, especially Douglas and Albinus, they have been classified according to the regions which they occupy; and this method, which is certainly more strictly anatomical, has been more or less adopted by Innes, Sabatier, Bichat, and Boyer. To the first method the principal objection is, that the same muscle may pertain to different classes of organs, and may effect different purposes in each; while of the second it must be admitted, that it communicates no information regarding the remarkable part which the muscles perform in the complicated processes of the animal machine. This consideration it was which induced Albinus, after a minute description of the situation, connections, and separate actions of each muscle of the human body, to construct a table representing the various classes into which they may be divided, according to the parts on which they act; for the same reason, doubtless, Soemmering arranged them according to the organs to which they belong; and for the same reason Portal, after a description equally minute with that of Albinus, gives a second account of the muscles as they are observed to act in the living body.

In the following tabular view, modified from that given by Albinus in the fourth book of his *Historia Musculorum*, the muscles are arranged according to their regions.

Muscles of the Head, Neck, and Vertebral Column.

Latissimus colli. (Π.)	Rectus capitis posticus major.
Sterno-mastoideus. (σr.)	Rectus capitis posticus minor.
Splenius capitis. (s.)	Obliquus capitis superior.
Splenius cervicis.	Obliquus capitis inferior.
Biventer cervicis.	Rectus lateralis.
Complexus. (c. c.)	Rectus capitis anticus major.
Trachelo-mastoideus.	Rectus capitis anticus minor.
Transversus cervicis.	Longus colli. (l.)
Cervicis descendens.	Scalenus anticus.
{ Longissimus dorsi. (LO.)	——— medius. (sc.)
{ Sacro-lumbalis, and	——— posticus.
{ Spinalis dorsi. (s.)	Intertransversi colli priores.
Spinalis cervicis.	Intertransversi colli posteriores.
Semi-spinalis dorsi.	Intertransversi dorsi.
Multifidus spinæ.	Intertransversi lumborum.
{ Interspinales cervicis.	
{ ——— dorsi.	
{ ——— lumborum.	

Muscles of the Chest.

Sterno-costalis.	Levatores costarum breviores.
Serratus posticus superior.	Intercostales externi
Serratus posticus inferior.	Intercostales interni.
Levatores costarum longiores.	

Common to the Chest and Abdomen.

Septum transversum, *sive* Diaphragma.

Muscles of the Abdomen and Loins.

Obliquus externus. (o.)	Quadratus lumborum.
Obliquus internus.	Psoas parvus.
Rectus. (R. R.)	Psoas magnus.
Pyramidalis.	Iliacus internus.
Transversus. (T.)	

Muscles of the Thoracic Extremities.

The Shoulder.

1st Order.	Supraspinatus. (s. s.)
Subclavius.	Infraspinatus. (i. s.)
2d Order.	Teres minor. (t.)
Serratus magnus. (s.)	Teres major. (T.)
Cucullaris. (c. c.)	Subscapularis.
Rhomboideus major. (P.)	*4th Order.*
Rhomboideus minor.	Latissimus dorsi. (L.)
Levator scapulæ. (L. s.)	Pectoralis major. (P.)
3d Order.	Pectoralis minor. (P.)
Deltoides. Δ.	

Muscles of the Arm.

Coraco-brachialis.	Triceps brachii. (Tr.)
Biceps brachii. (B. b.)	Anconeus.
Brachialis internus. (Br.)	

Muscles of the Fore-Arm and Wrist.

Supinator longus. (s.)	Ulnaris internus.
Radialis externus longior. (F.)	Radialis internus.
	Pronator teres. (Pr.)
——— brevior.	Pronator quadratus.
Ulnaris externus.	Supinator brevis.

Muscles of the Hand and Fingers.

Extensor communis.	Abductor brevis pollicis
Extensor proprius auricularis.	Opponens pollicis.
Abductor longus pollicis.	Flexor brevis pollicis.
Extensor minor pollicis.	Adductor pollicis.
Extensor major pollicis.	Palmaris brevis.
Indicator.	Abductor digiti minimi.
Palmaris longus. (p.)	Flexor parvus digiti minimi.
Sublimis. (F. s.)	Adductor ossis metacarpi digiti minimi.
Profundus. (F.)	Interossei interni.
Flexor longus pollicis.	Interossei externi.
Extensor brevis indicis.	Abductor indicis.
Lumbricales.	

Muscles of the Pelvic Extremities.

The Hip.

Glutæus magnus. (GL.)	Obturator internus. (ob.)
Glutæus medius. (G. I.)	Obturator externus.
Glutæus minor.	Quadratus femoris. (q.)
Pyriformis.	*Psoas magnus.*
Gemini. (g. g.)	*Iliacus internus.*

Muscles of the Thigh.

Biceps cruris. (B.)	Vastus externus. (v.)
Semitendinosus. (s. T.)	Vastus internus. (v.)
Semimembranosus. (s. M.)	Cruralis.
Tensor vaginæ femoris. (T.)	Pectinæus.
Sartorius. (s.)	Adductor longus. a.
Gracilis. (g.)	Adductor brevis.
Rectus.	Adductor magnus. a.

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Muscles of the Leg and Tarsus.

Gemellus.	Peronæus longus. (p.) Its tendon in the groove of the cuboid bone.
Plantaris.	Peronæus brevis.
Solæus.	Extensor l. digitorum pedis.
Poplitæus.	Peronæus tertius.
Flexor longus digitorum pedis.	Tibialis anticus.
Flexor longus hallucis.	Extensor proprius hallucis.
Tibialis posticus.	

Muscles of the Foot and Toes.

Extensor brevis digitorum pedis.	Abductor digiti minimi pedis.
Flexor brevis digitorum pedis.	Flexor brevis digiti minimi pedis. (f.)
Abductor hallucis.	Transversus pedis. (tr.)
Flexor brevis hallucis. (F. 4.)	Lumbricales pedis.
Adductor hallucis. (a. d.)	Interossei interni pedis.
	Interossei externi pedis.

Muscles of the Lower Jaw.

Biventer maxillæ.	Pterygoideus externus.
Masseter.	Pterygoideus internus.
Temporalis.	

Muscles common to the Hyoid Bone, Tongue, and Larynx.

Omohyoideus.	Styloglossus.
Sternohyoideus.	Mylohyoideus.
Sternothyroideus.	Geniohyoideus.
Hyothyroideus.	Hyoglossus.
Thyroideus.	Genioglossus.
Stylohyoideus.	Lingualis.

Muscles of the Palate and Pharynx.

Levator palati.	Palato-pharyngeus.
Azygos uvulæ.	Stylo-pharyngeus.
Circumflexus palati.	Salpingo-pharyngeus.
Constrictor isthmi faucium.	Constrictores pharyngis.

Proper Muscles of the Larynx.

Crico-thyroideus.	Arytænoideus transversus.
Crico-arytænoideus posticus.	Thyro-arytænoidei.
Crico-arytænoideus lateralis.	Thyro-epiglottici.
Arytænoideus obliquus.	

Muscle of the Scalp.

Epicranius. (E, bE, bE, E.)

Muscles common to the Face and Eye.

Orbicularis palpebrarum. (o.o.)	Levator palpebræ superioris.
Corrugator supercilii.	

Muscles of the Nose.

Compressor narium. (c.)	Nasalis labii superioris. (N.)
Levator labii superioris alæque nasi. (L.)	Depressor alæ nasi. (d.)

Muscles of the Lips.

Levator labii superioris.	Depressor labii inferioris.
Zygomaticus minor. (z.)	Buccinator. (t.)
Zygomaticus major. (Z.)	Orbicularis oris. (o. o.)
Levator anguli oris.	Anomalus maxillæ superioris
Depressor anguli oris.	Levator menti.

Muscles common to the Ear and Scalp.

Attollens auriculam.	Minor helicis.
Prior auriculæ.	Tragicus.
Retrahens auriculam.	Antitragicus.
Major helicis.	Transversus auriculæ.

Proper Muscles of the Eye.

Attollens. (A.) Plate XXXIII. fig. 6.	Adductor. Ad.
Depressor. (D.)	Obliquus superior. Tr.
Abductor. (Ab.)	Obliquus inferior.

Proper Muscles of the Ear.

Laxator tympani major.	Tensor tympani.
Laxator tympani minor.	Stapedius.

Muscles of the Anus and Perinæum.

Transversus perinæi.	Levator ani.
Transversus perinæi alter.	Coccygeus.
Sphincter ani externus.	Curvator coccygis.
Sphincter ani internus.	

Muscles proper to the Male Generative Organs.

Cremaster.	Bulbo-cavernosus.
Ischio-cavernosus.	Compressor prostatæ.

Muscles proper to the Female Generative Organs.

Ischio-clitoridæus.	Depressor urethræ.
Constrictor vulvæ.	

The limits assigned to the present treatise preclude particular details on the situation and relations of this numerous list of muscular organs. Any description sufficiently minute for the purpose of explaining the situation, attachments, relations, and actions of the muscles of the different regions, would be tedious in the extreme, and would not be intelligible without dissection; and no description according to their actions only would be intelligible, without a previous account of their anatomical relations. For these reasons it seems most expedient to direct the attention of the reader to a few general circumstances only. For descriptive details the reader will study with advantage the third book of the elaborate and accurate *Historia Musculorum* of Albinus, or the more recent treatise of Sandifort. The descriptions of Innes are clear, short, and sufficiently minute; and a good account of the muscles, as they appear on exposition, is given in the *London Dissector*. Of systematic treatises, the second volumes of those of Soemmering, Portal, and Bichat are the best.

This section, therefore, we shall conclude with such a general view of the muscles as agents in the attitudes and motions of the trunk and extremities, as, with the occasional remarks on their situation and connections in describing the bones, may be easily intelligible. It is further proper to advert briefly to those of the flexor muscles of the fingers, partly with the view of illustrating the general effects of muscular action, partly to show the mechanism by which the hand and fingers are enabled to execute such a variety of nice and delicate motions.

Muscles of the trunk.

The muscles of the trunk are employed not only as agents of motion and sustentation, but as the protecting walls of the large cavities. Thus the external and internal ranges of intercostals, the two pectorals, and the *serratus magnus*, operate not only in moving the ribs and shoulder respectively, but in contributing to complete the walls of the thorax, and to protect the internal organs. The diaphragm is not only an agent in enlarging the chest downwards, but constitutes an essential partition between the thoracic and abdominal viscera, prevents the lungs and heart from descending into the abdomen, and the stomach and bowels from being thrust upwards into the chest. These characters are still more conspicuously displayed in the *recti abdominis*, *obliqui externi et interni*, and *trans-*

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versi abdominis, which operate a little in drawing the chest downwards and compressing it before and on the sides, but act much more powerfully as retaining and supporting walls of the abdominal viscera, counteracting by the inward and upward action the downward impulse of the diaphragm. In this manner the abdominal *viscera*, placed between two opposing but equally balanced powers, are retained in the cavity, and prevented from being protruded upwards or downwards, while they are subjected to the alternate motions of inspiration and expiration.

The muscles of the trunk are employed in retaining that part of the skeleton in the erect attitude, in balancing it properly on the pelvic extremities, in occasionally inflecting and extending it, in bending it to one side, or in producing rotation. Those of the spine and back are particularly the agents of the erect attitude, and of extension; and those of the anterior region are employed in inflecting the person.

Muscles of the thoracic extremities.

The muscles of the superior extremities taken together are the agents of numerous varied motions. Though the principal object of the thoracic extremities is *prehension*, or embracing any object or objects firmly either by one or both hands, this may be modified in various ways, so as to give rise to prepulsion, traction, and constriction; while diduction and circumduction are the result of the combinations of the simple movements,—abduction, adduction, flexion, and extension.

Prepulsion.

Prepulsion may be either instantaneous or continued. The first takes place in the act of inflicting a blow or repelling an object. All the flexors are previously put in action to shorten the member, which is then at once forcibly extended, and communicates a violent shock to the part of the object to which its extremity is applied. Of this motion, in which the extension takes place in the scapulo-humeral and humero-cubital articulations, the deltoid and *brachialis externus*, or third head of the *triceps*, are the chief agents. The wrist and fingers are almost passive. But an analogous motion is executed by the latter in giving a fillip. In continuous prepulsion, for instance, or the act of impelling an object, the mechanism is of two kinds. In the first case, the member being previously extended and supported on the object, the individual inclines the trunk, and avails himself of its weight; while the member, remaining passive, becomes a lever moved by gravity. In the second case, the continued action of the extensors retaining the member forcibly extended, impels the object without interruption. When, for example, a man pushes a wheel-carriage before him, the superior extremities are extended and communicate motion to the carriage, while the trunk approaching it immediately, the extremities are again inflected, and so forth successively. In most instances this twofold mechanism is combined. When in prepulsion the body impelled is fixed, the impulse is thrown back on the person of the prepelling agent. Examples of this effect of prepulsion are observed in the act of rising from a seat by the occasional use of the thoracic extremities, and in pushing a vessel from the shore by means of an oar or pole.

Traction.

Traction, which consists in a general action of the flexors of the thoracic extremities, is directly the reverse of prepulsion. Its effect is to diminish the space between the agent and the object drawn, which takes place by shortening the member; while in prepulsion this space is enlarged by elongating or extending the member. In the case of a very great effort, for instance that of detaching a piece of wood strongly fixed in a wall, the action of the flexors is aided by the weight of the trunk, which is instinctively inclined in the opposite direction; and if the body drawn yields at once, a fall is often the result, because in this inclination the centre of gravity is subverted. In another form of traction, in which the body grasped does not yield, and when the action takes place upwards, the effect is to elevate the person of the agent by the flexors of the superior, and even occasionally of the inferior extremities. Familiar examples of this are afforded in the act of climbing walls, trees, and occasionally rocks, in ascending the rigging of a ship, and still more forcibly in the manner in which the active seaman ascends a single rope.

Constriction.

Constriction consists in the forcible and continued inflection either of a single hand or of the whole of both members. In the first case the agents are the superficial and deep flexors, and the flexors of the thumb and little finger; and in the second, with the action of these muscles, that of the *biceps*, *brachialis internus*, and *coraco-brachialis* is combined. This motion can neither be so sudden as that of prepulsion, nor, like it, can it be aided by the weight of the person.

Diduction.

Diduction, which consists in the forcible separation of the upper extremities from each other, as in swimming, is effected partly by the *latissimus dorsi* and *teres major*, partly by the posterior *fasciculi* of the deltoid moving the whole extremity in the scapulo-humeral articulation.

Circumduction.

Circumduction, which also is exclusively confined to the scapulo-humeral articulation, is effected principally by the deltoid, large pectoral, *latissimus dorsi*, *teres major*, &c.; while rotation is performed by the *supraspinatus*, *infraspinatus*, *teres minor*, *subscapularis*, &c.

Gesture.

Besides these general classes of motion executed by the thoracic extremities, to them also belongs the power of assuming many of those attitudes and all the varieties of gesture which man employs for the purpose either of expressing his feelings or giving significance and animation to the language which he adopts for that purpose. How much these gestures, when well chosen and properly introduced, aid both the expression of the countenance and the language of the lips, is well known to the public speaker and the dramatic performer.

Motions of hand and fingers.

Besides the ordinary flexors of the wrist (*radialis externus et internus*, *ulnaris internus*), there are two common flexors of the fingers, one superficial (*sublimis*), the other deep-seated (*profundus*); the thumb has a long and short flexor, and the little finger has a short flexor. The flexor muscles, therefore, may be distinguished into four orders; those common to the wrist and hand, those common to the hand and fingers, those proper to the fingers, and those proper only to some of the fingers. Though the *radialis internus* and *ulnaris internus* chiefly bend the wrist and hand, yet both the superficial and deep flexors, by passing beneath the annular ligament, co-operate in the same motion, and necessarily bend the hand previous to their final action on the digital phalanges. In this they are considerably aided by the action of the *palmaris longus* and the *palmaris brevis*, which render the palmar aponeurosis tense, and enable it to afford the necessary resistance to the subjacent flexor tendons.

The superficial flexor, the tendons of which are inserted into the anterior and citerior part of the second row of phalanges, has the effect of bending that part of the fingers, and further, by being bound down by a ligamentous sheath to the first phalanx, inflects them at the same time into the palm. The slits in each tendon allow those of the deep flexor to pass forward on the median line of each phalanx, to be inserted in the unguinal phalanges, and thereby to operate most directly and perfectly in inflecting them on the palm; and, by being confined also in the same sheath by strong ligamentous bands, aid in inflecting the second and first range of phalanges. (Plate XXVIII. fig. 2 and 3.)

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Minute flexion and extension.

These actions are further facilitated and modified by another class of muscles. The *lumbricales*, which, situate in the palm, are attached above to the tendons of the *flexor profundus*, and inserted sometimes into the extensor tendons, sometimes into the lateral regions of the phalanges, may either concur with the *profundus* in bending the first phalanges, or they may adduct or abduct the fingers, according to the separate or conjunct motion; and hence are of the utmost importance in all nice and minute motions of the fingers. Without the *lumbricales*, which are peculiar to man, it would be impossible for the human fingers to execute those minute and rapid movements which are necessary in performing on musical instruments; and the great advantage which one individual possesses over another in what is denominated *execution*, consists chiefly in the perfect use of these little muscles. In playing on the piano-forte especially, the *lumbricales* are of the most essential service; and though the superficial flexor enables a lady to strike the keys, the former must be employed in the more minute and delicate motions requisite in the transition through numerous chords.

In this action the *internodii* at the same time appear to be auxiliary; and their connections are calculated to modify the action of the flexors.

Opposition of thumb and fingers.

Another peculiarity in the human hand consists in the four muscles with which the thumb is provided, and the two connected with the little finger. By means of its short abductor, short flexor, and adductor, the thumb may be separated, inflected, and approximated to the hand quite independently of the fingers, and with the utmost precision. But from the *opponens* it derives the remarkable property of being accurately and precisely applied to the tip of any one of the fingers, and thus made to grasp minute objects, which could not without this be effected. From this muscle, in short, the human hand derives its power of appliance to all the arts requiring nice manual operation. Without the *opponens* there is no penmanship, no painting, no drawing, no tracing, no needlework, no engraving; in short, none of those operations requiring the obedience of the hand to the conceptions of the mind and the guidance of the eye.

General movements of the pelvic extremities.

The movements of the lower extremities are less distinguished for precision and delicacy than those of the superior; and though the foot has both *lumbricales* and *interossei*, the brevity of the phalanges compared with the length of the metatarsal bones, and the close connection of the toes, form insurmountable impediments to the rapidity and nicety of motion which is observed in the inflections of the fingers. The circumstance, however, which places the foot at an immeasurable distance behind the hand as an organ of prehension, is the want of the *opponens*. Void of this, the human foot is little more than the foot of the quadruped, constituting chiefly a base of support, and susceptible of such motions only as are requisite to progression. It is expedient, therefore, to consider shortly the agents by which these functions are performed.

Station on both legs.

Station, or that attitude in which man supports himself in the erect position on a horizontal plane, is effected by the foot being planted firmly on the ground by means of the *gemellus, solæus, tibialis anticus, peronæus longus et brevis, flexor longus communis digitorum pedis, flexor hallucis proprius, flexor hallucis brevis, flexor brevis digiti minimi et digiti medii*, the *lumbricales*, and *interossei*. At the same time the leg is fixed to the ground by numerous muscles,—before by the extensors of the great toe and toes generally, by the *peronæus tertius*, partly by the *tibialis anticus*; externally by the *peronæi longus et brevis*; within by the *tibialis anticus* and *posticus*; and behind by the *gemellus, solæus, semitendinosus*, and long flexors of the toes. The knee is at the same time stretched by the four extensors, aided by the *tensor vaginæ femoris*.

Equipoise.

The equilibrium of the trunk and pelvis on the heads of the thigh-bones is maintained by several powerful muscles, connecting the former to the latter. Before, for instance, this action is performed by the *sartorius, rectus*, the two *psoæ*, and the *iliacus internus*; behind by the *biceps, semitendinosus*, and *semimembranosus*; without by the *glutæus* and *tensor vaginæ femoris*; and within by the *pectinæus*, the adductors, and the *gracilis*. By these muscles the pelvis is impelled on the axis of the two *femora* only, and is prevented from inclining in any other direction. To maintain the trunk above the pelvis in the same steady position, numerous other muscles concur. Behind are the various extensors of the vertebral column and trunk, the *longissimus dorsi* and *sacro-lumbalis* on each side, the *cervicis descendens, splenius* and *biventer cervicis*; the *transversi cervicis*, and *spinalis cervicis et dorsi*; the *semispinalis, multifidus*, and *interspinales* on each side. Before are the sterno-mastoid, the great and small anterior *recti*, the *longi colli*, and anterior *scaleni*; and on each side are the trachelo-mastoid, the lateral *scaleni*, the *intertransversi*, and the lateral *recti*. In this enumeration it is manifest that the muscles of the posterior surface of the trunk and spine are at once more numerous and more powerful than those on the anterior,—an arrangement which is rendered necessary to counteract the effect of the weight of the thoracic and abdominal viscera on the anterior side of the vertebral column, which is thus rendered liable to anterior incurvation, and which becomes so in old age, notwithstanding the agents now mentioned.

This circumstance is further illustrated in the number and size of the muscles by which the head is retained in the erect position, and prevented from inclining forwards. These are the *cucullares*, the *splenii capitis, biventres cervicis*, and posterior *recti* on each side—all powerful, and several of them large.

Station on both pelvic extremities, therefore, requires the co-operation of a very considerable number of powerful muscles; and it is a mistake to imagine, as some authors appear to do, that a small degree of muscular energy is requisite for this purpose, and that the skeleton is the chief means of maintaining the erect position. Without the skeleton, as points of support, the muscles cannot act; but without the muscles the bones are passive brute matter.

Station on one leg.

In station on one extremity only, a different and certainly a less degree of muscular action is requisite. All the external muscles of the fixed member are at first strongly contracted, to prevent it from gliding inwards, in which direction the trunk, not supported by the opposite limb, tends to impel it. Proceeding from below upwards, we find the lateral *peronæi*, the *vastus externus*, and even the *rectus*, draw the limb outwards; while the *tensor vaginæ femoris*, the *glutæus medius* and *minor*, carry the pelvis, and with it the trunk, in the same lateral direction. In this case the weight of the person is employed in antagonizing the muscles of the side thrown into action; and the person is balanced between these two forces.

Elevation on the tip of the foot is effected chiefly by the action of the muscles, which extend the *phalanges* on the metatarsal bones, viz. the *tibialis anticus, extensor hallucis, extensor longus digitorum*, and even the *extensor brevis*; all of which must fix the leg before, and the tarsal and metatarsal part of the foot on its phalangeal region, before the latter can be employed to elevate the person These extensors, therefore, perform in the tip-toe attitude the duty which the *gastrocnemius* and *solæus* execute behind in ordinary station; and the smaller power

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of the former readily explains the difficulty of maintaining this attitude for a long time.

Progression.

Progression or gait (*incessus*) consists in the anterior propulsion of the person by the alternate propulsion of each pelvic extremity. In this, therefore, not only are the muscles necessary to maintain the erect position put in action, but those which bend the lower extremity on the trunk operate on one side, while the extensors of the other maintain that extremity for the instant fixed. Progression consists of a series of steps (*passus*); and each step consists in the antero-posterior separation of the pelvic extremities by the propulsion of one, while the other remains fixed. Supposing the left foot to be the fixed one, the right foot is elevated, and the leg is propelled by the contraction of the *gemellus, solæus, semitendinosus, tibialis anticus et posticus;* while at the same time the extensors of the knee raise the leg, and the *psoas, iliacus, pectinæus, triceps adductor, sartorius* and *gracilis,* with the *tensor vaginæ femoris,* raise and stretch the whole limb. When this is accomplished, the right foot, with the knee extended, the elevating muscles being relaxed, and the trunk, are inclined forwards, and the foot is planted at some distance before the left.

In this motion, however, in which the trunk is carried forward by the *recti* and *obliqui abdominis,* and downward by the *psoæ* and *iliaci interni,* and the leg by the long flexor and the anterior *peronæus,* a fall would be the immediate result, unless the knee, to preserve equilibrium, were somewhat bent, and the other foot at the same time began to assume the same action. While the toes, therefore, are forcibly impelled by their flexors to the ground, the two *gastrocnemii,* the anterior and posterior *tibiales,* and the *peronæi,* elevate the foot with the sole backward, and bend the knee, and the *psoas* and *iliacus* raise and extend the whole member.

Running.

Running differs from progression, not only in velocity, but in the mode of its accomplishment. Not only are the pelvic extremities more inflected and moved than in mere walking, but they remain inflected. Thus, while the trunk is inclined forward on the pelvic extremities by the *recti cruris,* the *psoæ* and *iliaci,* the two latter with the *pectinæus longus,* the *adductor longus* and *brevis,* and the *tensor,* are employed to inflect the thigh, the *semitendinosus, semimembranosus,* and *biceps* to inflect the leg, and the anterior *tibialis,* great and small extensors of the toes, and extensor of the great toe, are employed to bend the foot and the phalanges on the metatarsal bones. The last action is essential to running, which is always most perfect on the tip of the foot. In this movement also the centre of gravity is constantly undergoing change, and is not only carried forward, but makes a sort of undulating motion on each side, and above and below the plane of motion. This is the effect of the pectoral extremities being employed to balance the person.

Leaping.

In leaping, the pelvic extremities are much inflected, and the sole of the foot rendered tense, by the *gastrocnemius, solæus, tibiales,* and *peronæi,* while the extensors are employed to raise the phalangeal part of the foot; when the person is forcibly impelled forward by the *gastrocnemius, solæus,* the leg suddenly contracting on the *cruræus* in the thigh, and the *glutæus, semitendinosus, semimembranosus,* and *biceps* in the pelvis.

Dancing.

In dancing, the muscles are made to co-operate in producing a number of complicated motions. In most of the motions composing the dances practised in ordinary society, while the muscles of the pectoral extremities are employed in balancing the person, and those of the trunk in maintaining it in the erect attitude, the flexors and extensors are employed to diduct, inflect, or extend; to cross the extremities with more or less rapidity; and, while the extensors and *tibialis anticus* elevate the person on tip-toe, the lateral *peronæi* are employed to evert the foot and point the toes.

CHAP. II.—THE ORGANS OF SENSATION.

The organs of sensation may be distinguished into two orders, according as their province is to recognise general or peculiar affections and qualities in external objects. Thus, while it is the purpose of touch to recognise the consistency, shape, and resistance of bodies, it communicates no information regarding their colour, smell, or taste, or the effects which their collision produces in the vibrations of the atmosphere. With these affections of the material world man becomes acquainted by means of organs of a peculiar construction, and adapted to receive the impressions occasioned by these qualities. These organs are, for smell, the nostrils and their appendages; for colour and the general purposes of sight, the eye; for taste, the palate and mouth; and for sound, the ear. For the purposes of common sensation the skin is the agent; but on the structure of this membrane it is unnecessary to add any thing to what has been already said in the General Anatomy, unless that in certain regions, for instance the tips of the fingers, the erectile arrangement of the capillaries, with a minute distribution of nerves, and great thinness of cuticle, communicates the delicacy necessary to the refined purposes of tact.

SECT. I.—THE ORGAN OF SMELL; THE NASAL CAVITIES.

The organ of smell consists of an external part for receiving and transmitting substances capable of producing the sensation of smell; and an internal part, in which this sensation takes place.

The nose (*nasus*), which constitutes the external part, is a pyramidal eminence, bounded above by the forehead, below by the upper lip, and on the sides by the orbits and cheeks. It has two anterior-inferior oval-shaped lateral openings named the nostrils (*nares*), separated by a partition. It consists above of the nasal bones and the nasal processes of the superior maxillary bones, covered by periosteum, cellular tissue, part of the *compressor narium,* and skin. Below, it consists of membranous fibro-cartilages, attached to the nasal bone and superior maxillary above and behind, and supported by a middle cartilage (*septum narium*), which rests on the fissure of the *vomer* below, and is fixed to the vertical plate of the ethmoid bone above, and to which is attached a slip of fibro-cartilage before, named *columna nasi.* The lateral fibro-cartilages, which are occasionally named wings (*alæ nasi, pinnæ nasi*), covered by cellular tissue, muscles, and skin, liberally supplied by blood-vessels and sebaceous follicles, are moved by the *levator, compressor,* and two depressors. These parts, with the middle *septum* and *columna,* are lined by a form of mucous membrane named the pituitary or Schneiderian. The nose.

To what was already said of the nasal cavities under the head of Osteology it is superfluous to add any thing, unless what relates to the lining membrane, the distribution of which is exactly according to the extent of the bony walls of these cavities and their subdivisions.

This membrane consists of two layers; a *fibrous,* which is the periosteum or perichondrium of the nasal cavities; and a *mucous,* resembling the other forms of this tissue. It is soft, spongy, red, and more or less vascular, with an attached and a free surface, the latter secreting the thin mucus necessary to preserve the membrane in a proper state for receiving odorous impressions. In this mem- Narine membrane.

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brane mucous glands are indistinct; but we recognise minute orifices or pores, which may be the follicular cavities on a small scale, or the orifices into which the mucous fluid is poured after secretion by the arteries.

This mucous membrane is supplied from the internal maxillary artery with blood-vessels, which are at once abundant and superficial. These anastomose with the infra-orbital and ethmoidal branches of the ophthalmic artery and some others of the internal carotid. On these circumstances depends the frequency of hemorrhages from this membrane in early life, while the capillary system is energetically employed in the enlargement of the cranio-facial region; and in advanced life, when venous *plethora* is most conspicuously evident in the vessels of the head.

The nerves which supply the nasal cavities are the first or olfacient nerves principally, the internal nasal of the ophthalmic, and several branches derived from the spheno-palatine ganglion, the frontal, the great palatine, and the vidian. The distribution of these nerves has been beautifully represented by Scarpa (*Annot. Acad.*), from whom fig. 1 and 2 of Plate XXXIII. are imitated.

SECT. II.—THE ORGAN OF VISION; THE EYES.

The eyes, placed in the orbits, are distinguished into the globes of the eyes, and their appendages.

The globe or ball of the eye, situate at the base of the orbit, has a spheroidal shape, with the antero-posterior diameter longest, and varying in the adult from 10 to 11 lines. The direction of the eye differs from that of the orbit, the axis of which is oblique and convergent behind, while that of the two eyes is parallel.

The eye-ball (*bulbus oculi*) consists of several membranes, containing fluid or semifluid substances, denominated humours. The external and strongest is the sclerotic, with the *cornea* enchased in its anterior aperture; next is the choroid and retina; and the iris, a circular membrane, with an annular aperture, is placed transversely across, dividing the cavity into anterior and posterior chambers. The humours are the vitreous, the crystalline lens, and the aqueous humour.

The sclerotic.

The sclerotic, sometimes named *cornea opaca*, in contra-distinction to the clear cornea, is shaped like a spherical shell, truncated before, and is estimated to occupy about four fifths of the globe. Its exterior surface is covered by the adipose matter of the orbit behind, and by the tendons of the muscles of the eye and the ophthalmic *conjunctiva* before. Its inner concave surface is lined by the choroid coat. In its anterior opening, which is about six or seven lines diameter, the cornea is enchased by imbrication of the sclerotic; and in a posterior opening about one and a half line in diameter, the ophthalmic end of the optic nerve is fixed. It is fibrous in structure, becoming translucent when immersed in oil of turpentine. Its vessels are generally colourless, and it appears void of nerves.

The cornea.

The *cornea*, often named the clear or transparent *cornea* (*cornea lucida*), to distinguish it from the opaque cornea or sclerotic, which was supposed by the old anatomists to be of the same nature, is a segment of a smaller sphere than that of the sclerotic, attached to its anterior aperture, and occupying the anterior fifth of the eyeball. Before it is covered by a thin pellicle continued from the *conjunctiva*, behind by the anterior part of the membrane of the aqueous humour; and its circumference is inseparably enchased within that of the anterior aperture of the sclerotic. The cornea consists of several concentric layers of transparent homogeneous matter, void of vessels or nerves, closely united, but separating and becoming opaque after death.

The choroid coat.

The choroid coat (*tunica choroides*) lines the inner surface of the sclerotic, to which it adheres loosely, except at the insertion of the optic nerve, where it has a posterior opening, yet may be easily detached. The margin of its anterior opening, which is large, adheres to the ciliary circle and processes, and appears to be continuous with the iris. The outer surface is covered by a brownish-black viscid matter, which partly adheres to the inner surface of the sclerotic. The inner surface, over which the *retina* is extended without adhesion, is covered by the same brownish-black matter; but of this the retina receives none, as the sclerotic. The choroid is a thin membrane, of a grayish colour when deprived of its brown pigment, translucent, homogeneous, and, so far as observation goes, void of fibres, but liberally supplied by minute blood-vessels, partly from the long, chiefly from the posterior ciliaries, which, dividing on its outer surface into numerous ramifications, mutually approximate, and anastomosing, form a network of quadrilateral and trapezoidal meshes. The *tunica Ruyschiana* is imaginary, unless this arrangement of capillary vessels be such.

Pigmentum nigrum.

From these vessels is derived the brownish-black matter (*pigmentum nigrum*) with which the retinal surface of the choroid is covered. Its appearance on the convex or sclerotic surface is the effect of cadaveric transudation. The nature of this colouring matter is imperfectly known. When first secreted it is brown, but becomes black successively as it continues. It is not affected by the action of light or caloric, and undergoes no change from the operation of the mineral acids, *aqua potassæ*, ammonia, and alcohol. It appears to consist chiefly of carbonaceous matter. Menghini asserts that he has obtained from it minute particles of iron attracted by the magnet.

Ciliary circle.

The anterior orifice of the choroid is firmly connected to a thick ring of grayish pulpy substance, and forming the point at which the sclerotic and cornea without, and the iris within, are united. This ring, named the ciliary circle (*ligamentum ciliare*), is readily detached from the sclerotic. Its structure is unknown.

Ciliary processes.

Posterior to this is a range of prominent minute bodies, with free extremities, lying over the crystalline lens, varying in number from seventy to eighty. These are the ciliary processes (*processus ciliares*). They are trilateral-prismatic in shape, about a line and a half long, more distinct and longer in the human eye than in those of most brute animals. Their intimate structure is not very well known; but they are highly vascular, and their vessels appear to be capable of occasional erection. (Plate XXX. fig. 4.)

The iris.

Anterior to the ciliary circle is the iris, a circular membrane, placed in the transverse vertical position, with anterior and posterior surfaces, and a circular opening in the centre. The exterior ciliary margin (*annulus major*) is attached, as already stated, to the ciliary circle. The inner or pupillar (*annulus minor*) is free, and forms what is named the pupil of the eye. The anterior surface is marked by a variety of colours, blue, gray, or black, brown, or that peculiar brownish-black named hazel, and which are not unfrequently allied with the tints of the skin and hair. The same surface presents radiating lines, which pass from the small to the large circle diverging. Both appearances are produced by vascular arrangement. The posterior surface of the iris, which has been distinguished as a separate membrane under the name of *uvea*, is covered by the same dark-coloured matter secreted by the choroid, generally more abundant, and of a deeper tint, than the pigment of that membrane. When this is removed by washing, the observer recognises the radiated streaks impressed by the ciliary processes. (Fig. 4.)

Structure of the iris. The different characters of these two surfaces have induced some anatomists to distinguish the iris into anterior and posterior membranes. Though it has some thickness, this is perhaps a fanciful refinement. The anterior surface, which is continuous with the membrane of the aqueous humour, is different from the posterior, which is continuous with the ciliary circle and choroid. The structure of the iris is chiefly vascular, and its vessels have an erectile arrangement.

Its erectile system. The long ciliaries, from which these vessels are derived, divide each at the ciliary body into two branches, which divaricating at obtuse angles, unite with several of the anterior ciliaries, and form with them, beyond the ciliary ligament at the large circumference of the iris, an arterial circle. From this arise smaller branches, which, crossing, unite and form within this a second smaller arterial circle, midway between the ciliary and central margin; and from the concavity of this proceed very minute vessels, which radiate in a flexuous manner, and converge towards the pupil, where, anastomosing most minutely, they form a third circle—the marginal ring of that aperture.

Pupillary contractions, and their true cause. It is chiefly in the middle and inner anastomosing circles that the vessels assume the erectile arrangement; and on this circumstance, and not on that of muscular fibres, so often, so positively, so inconsistently, and so erroneously maintained to exist in the iris, does the mobility of that singular membrane depend. On exposure to direct or bright light, on the application of vinegar, alcohol, or any stimulating substance to the eye, and during the presence of inflammation, the erectile capillaries, distended with blood, are elongated, and necessarily contract the pupillary aperture. In the dark, under the influence of henbane (*hyoscyamus niger*), deadly night-shade (*atropa belladonna*), and some other narcotics, and when the retina is insensible, these vessels seem to lose their faculty of distension, and, perfectly empty and shrunk, allow the pupillar margin to approach the ciliary.

The retina. The retina, which is the third and internal tunic, is of the same shape as the choroid, thin, like cobweb, whitish, translucent, inclining to transparent, and very delicate. Its extreme tenuity and looseness from the choroid causes it to collapse unless inspected under water, when it may be unfolded and expanded for examination. Its outer surface is covered by a very delicate membrane, visible only in a very recent eye, discovered by Mr Jacob of Dublin. It is almost void of red vessels, unless at the part where the optic nerve enters, where one or two from the central artery may be seen. The others are colourless. The assertion that this membrane is an expansion or production from the optic nerve, seems to be gratuitous; for it bears no resemblance to nervous matter, or to the appearance of the optic nerve. It appears to be simply a peculiarly delicate transparent web, fitted to receive the impressions of luminous rays, and to communicate them to the optic nerve, with which it is continuous.

Spot of Sœmmering. On this membrane, about two lines on the temporal side of the optic nerve, and in the axis of the ball, is a circular yellow spot (*macula lutea*), from about a line to a line and a half in diameter, with a minute point or hole in its centre (*foramen centrale*). At this part the retina is much thinner than at any other; and even in the most recent eyes it presents loose folds, which Bichat regards as cadaveric. The yellow spot and its central hole are seen in none of the mammalia except man and the monkeys.

Vitreous humour. The vitreous humour, occupying about three posterior fourths of the eye, is spherical and convex behind and on its lateral circumference, but concave before for receiving the posterior part of the crystalline lens. Contiguous only to the retina, it is attached to the coats by the branch sent from the central artery to the lens. It is transparent, and consists of two parts, an investing membrane, the hyaloid (*membrana hyaloidea*), and inclosed fluid.

Hyaloid membrane. This membrane is not single, but, sending numerous partitions from its inner surface, forms an assemblage of cells in which the fluid is contained. These facts may be demonstrated by incision, bruising the humour, by congelation, or by boiling it. Before, at the outline of the lens, this membrane divides into two folds, one of which is stretched before the capsule, and the other behind. The trilateral-prismatic space resulting from this separation is completed by the capsule, and forms the circular canal of Petit, which is without fluid, and which is demonstrated by inflation. On the anterior fold the ciliary processes are stretched. The structure of the hyaloid membrane is little known; but it is believed to consist of exhalant arteries and colourless veins.

Hyaloid fluid. The hyaloid fluid may be separated from the membrane either by incisions or compressing it between two folds of linen. It then has the appearance of a clear but somewhat viscid fluid, like gum diluted with water. Though rendered slightly turbid by boiling water, acids, and alcohol, it does not coagulate,—a phenomenon which is to be ascribed to the small proportion of albumen which it contains. According to the analysis of Berzelius, 100 parts contain 98·4 of water, ·16 of albumen, 1·42 of muriates and lactates, and only $\frac{1}{50}$th of a part of soda.

Crystalline lens. The crystalline lens, which is transparent and shaped like an oblate spheroid, is situate in the posterior chamber, and in the anterior depression of the vitreous humour, to which the convexity of its posterior surface corresponds. Before also it is prominent and convex; and it is partially covered by the free extremities of the ciliary processes. It consists of two parts, an inclosing capsule and a lens proper.

Capsule. The capsule is usually distinguished into anterior and posterior walls, both covered by hyaloid membrane, both transparent, and both firm and resisting. By boiling water, alcohol, or the acids, it is rendered opaque, whitish, and horny; and it becomes yellow by contact with the air.

The lens, which is perfectly transparent, consists of two portions; an exterior, peripheral, thick, soft, adhesive, and easily removed; an interior, central, solid, and consisting of concentric plates. Both are indurated and rendered opaque by boiling water, alcohol, and dilute acids; but the central nucleus is the firmest. When dried in the air it becomes yellowish, but retains its transparency, and may be preserved for years. These phenomena are to be ascribed to the presence of a peculiar form of albumen. According to the analysis of Berzelius, 100 parts of the substance of the lens consist of 58· of water 35·9 of peculiar matter, chiefly albuminous, 2·4 of muriates, lactates, and animal matter soluble in alcohol, 1·3 of animal matter soluble in water, and 2·4 of membrane.

The lens possesses a high refracting power; and its chief use is to concentrate the luminous rays within the eye, so as to represent distinctly the image of visible objects on the retina. Spherical and transparent in early life, it is flattened and acquires a yellowish tint in old age.

Between the capsule and lens is found occasionally a fluid which has been named *liquor Morgagni*. It appears to be the effect of transudation.

On the structure of the lens, whether organic or not, anatomists vary. Vessels have not been recognised in it; and the most rational view is, that it is the product of an organic action probably in the capsule.

Aqueous humour. The aqueous humour is contained in the anterior chamber, and in that part of the posterior which surrounds the anterior surface of the lens and vitreous humour. It con-

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sists of 98·10 parts in the 100 of water, a trace of albumen, and about 2 parts of muriates and lactates of soda. It is contained in a membrane, which lines the posterior surface of the *cornea*, and is supposed to cover the anterior surface of the iris. This, however, is questionable. In 1768 a membrane of this kind was described by Demours and Descemet, both of whom claimed the discovery with great eagerness and some animosity. These rival anatomists appear to have forgotten that the aqueous humour may be secreted as well by the cornea and iris as by a proper membrane.

The relation of the coats and humours of the eye to each other may be understood by the diagram (fig. 3, Plate XXX.), where A is the anterior chamber, P the posterior, L the lens, and c, c the ciliary processes. The other parts are easily understood from the foregoing description.

The eye is supplied with blood chiefly by the ophthalmic artery.

Ocular muscles.

The eyeball, thus constituted, is moved in different directions by six muscles, is moistened externally by fluid secreted from a particular gland, and is protected from external bodies by the eyelids and their appendages.

Of the muscles, four are straight and two oblique. The former (*attollens, depressor, adductor, abductor*), attached to the margin of the optic hole, and terminating in tendons inserted into the superior, inferior, nasal, and temporal parts of the eyeball, raise, depress, adduct and abduct the organ. Of the two latter, the superior oblique (*trochlearis*), which is attached to the margin of the same hole, passes through a pulley-like cartilage at the inner margin of the vault of the orbit, and is inserted into the internal region of the ball, rolls the eye forward and inward, and turns the pupil outwards and downwards; while the inferior oblique, attached to the orbitar process of the superior maxillary bone, and inserted between the adductor and the optic nerve, rolls it forwards and turns the pupil upwards. These muscles, which occupy the apex of the orbit, are surrounded by a thick cushion of fat, on which the eyeball rolls in its movements. (Plate XXXIII. fig. 6.)

Lacrymal gland.

In the hollow, at the outer temporal region of the orbitar vault, is placed the lacrymal gland, a granular grayish body, about the size of a bean, consisting of lobules, with arteries in the intermediate furrows, derived from a branch of the ophthalmic, and accompanying veins. (Plate XXXIII. fig. 5 and 7, G, g.) These constituent lobules have been represented, on the authority of Steno in the ox, and the elder Monro in the human subject, to terminate in 7 or 8 minute excretory ducts, opening on the *conjunctiva*. In man, however, they were sought in vain by Duverney, Morgagni, Haller, and Zinn; and neither Portal nor Bichat have been able to satisfy themselves of the existence of these ducts. It is nevertheless certain that the lacrymal gland secretes the tears, and that the latter issue from its lobules.

Eyelids.

The eyes are covered anteriorly by two musculo-membranous folds named the eyelids (*palpebræ*), attached to the margins of the orbit, and forming by their free margin the palpebral opening, with commissures at each angle (*canthus nasalis, et canthus temporalis*).

The upper eyelid, which is large, is bounded above by the eyebrow (*supercilium*), a cutaneous eminence, arched transversely, covered with hairs, and with the *corrugator supercilii* attached to its nasal end. Between each eyebrow is a smooth space, named the *glabella* or *mesophryon*. Into the upper eyelid the levator (fig. 5, L) is inserted.

Each eyelid consists of skin externally, mucous membrane within (*conjunctiva*), intermediate cellular tissue, muscle, and a fibrous membrane, attached by one margin to the base of the orbit, and terminating by the other in the tarsal fibro-cartilages. These are crescentic bodies placed in the free margin of the eyelids, and by their firmness and elasticity giving the requisite tension to the eyelids when the orbicular muscle acts, or the *levator* is relaxed. The cutaneous border of the *tarsi* is occupied by a range of short, firm hairs, named the eyelashes (*cilia*). In the mucous borders are the orifices of the tarsal or Meibomian follicles, of the same character as the muciparous follicles generally. These are placed in the substance of the eyelid, beneath the *conjunctiva*, and behind the tarsal fibro-cartilages. From the inner surface of the eyelids the palpebral *conjunctiva* is continued over the anterior part of the sclerotic and cornea, forming the ophthalmic *conjunctiva*.

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Tarsi and glands.

Caruncle.

In the nasal angle is lodged a minute red body, named the caruncle (*caruncula lacrymalis*), chiefly consisting of filamentous tissue and vessels covered by mucous membrane; and behind this is a fold of the membrane, which has been named *membrana nictitans*, large in the lower animals, but often so imperfect in man as to be merely rudimentary.

Lacrymal orifices.

At the nasal end of each eyelid is a minute capillary orifice which leads into a horizontal canal, terminating in a membranous sac lodged in the depression of the lacrymal bone. These orifices, which are named the *puncta lacrymalia* (*p*, *p*, fig. 5), are the superior or palpebral openings of the lacrymal sac and passages, the lower aperture of which is found in the inferior nasal *meatus*. The tears effused from the lacrymal gland at the temporal region of the orbit are carried, by the frequent action of the orbicular muscle, over the ball, till they reach the nasal angle, where they are gradually absorbed by the capillary orifices of the *puncta*, and conveyed into the sac, and eventually to the nose.

Ocular nerves.

The eye derives nerves from six different sources, all of which, however, may be distinguished into three classes, the sensitive, motive, and entrophic nerves. The first consists of the second, optic or the proper visual nerves. The second class comprehends the third, fourth, and sixth nerves, of which the third or oculo-muscular are distributed to the *levator palpebræ superioris*, the *attollens*, the *adductor*, the *depressor*, and the *obliquus inferior;* the fourth is entirely distributed to the *obliquus superior;* while the sixth pair are confined to the *abductor*. The third class of nerves is derived from the ophthalmic or quadrilateral ganglion, which is formed chiefly from the junction of a sub-branch of the naso-ocular branch of the first or ophthalmic division of the fifth pair, with a small branch of the third nerve. From this arise a small superior cluster of three nerves adhering to the optic, and a large inferior cluster of eight or ten nerves, which quickly join the ciliary arteries, and are with them distributed in the ciliary circle and posterior part of the iris. (Plate XXXIII. fig. 7.) From the other branch of the naso-ocular nerve, the caruncle and lacrymal canal, with the orbicular muscle and *epicranius* on the one hand, and the lacrymal gland on the other, receive nervous filaments.

SECT. III.—THE ORGAN OF HEARING; THE EAR.

The organ of hearing consists of the auricle or external ear, with the ear-hole; the middle ear, including the tympanal cavity and its appendages; and the internal ear or labyrinth.

Auricle.

The auricle is a fibro-cartilaginous substance, moulded into a conchoidal shape, covered by skin, attached to the cranium by ligaments, and susceptible of motion by muscles. It is common to distinguish in it the following parts. The *helix*, a semicircular eminence above the ear-hole; the groove of the *helix* below it; the *antihelix*, an eminence commencing in the groove by a superior, broad,

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oblique portion, and an inferior, narrow, horizontal one; the *fossa navicularis;* the *tragus*, an anterior eminence below; the *antitragus*, a smaller eminence behind; the lobule, a pendulous body at the base behind; and, lastly, the *concha*, a deep conoidal cavity leading to the ear-hole.

The latter is a canal about 10 or 12 lines long in the adult. Twisted at first obliquely forward and upward, it bends slightly backwards and downwards, forming a convexity of incurvation above, and a concavity below. Though the extremities are large, the middle is contracted; and it cannot be termed cylindrical, for its section is elliptical or oval. The structure of this tube is fibro-cartilaginous externally where it adheres to the bone, lined by skin passing into mucous membrane, and occupied by minute follicles (*glandulæ ceruminosæ*), which secrete the wax (*cerumen*) formed in this canal. The nature of this secretion is imperfectly known. Though, like oil, it stains paper, it is partly soluble in tepid water, and forms with it a yellow emulsion. It is secreted at first fluid, and acquires consistence by exposure to air and admixture with dust. Alcohol has little influence on it. The internal extremity of the auditory canal is bounded by the vertical membrane of the *tympanum*.

Tympanal cavity.

Within this is the tympanal cavity, a space of an irregular cylindrical shape, directed obliquely, nearly in the axis of the pyramidal portion, in the base of which it is contained. This cavity is shut up externally by the vertical tympanal membrane (*membrana tympani*), and is bounded within by the bony partition which separates it from the labyrinth. The *membrana*, which is oval-shaped, or nearly round, and attached to the margin of the *meatus externus*, is directed obliquely downwards and inwards, and is so delicate that it is difficult to determine its structure in the human subject. In the elephant, however, and other large animals, it presents radiating fibres, which are believed to be muscular (Plate XXXVII. fig. 14); and Sir E. Home represents it as such not only in the elephant and whale, but in the human subject. The outer part is evidently a sort of epidermis, continuous with that of the canal; the inner is a mucous epidermis, continuous with that of the tympanal cavity; and between these the muscular fibres are interposed.

Eustachian tube.

The tympanal cavity communicates behind with the mastoid cells, and before and internally by the Eustachian tube, with the pharynx. This tube is estimated to be two inches in length, of which one and a half is in the bone of the pyramid, and about half an inch at its extremity, with the upper side completed by cartilage. Narrow at the tympanal end, it becomes wide and capacious towards the pharyngeal, and presents at length a free open extremity, forming a fissure at the upper and lateral part of the *pharynx*. The cartilaginous end is covered by mucous membrane continuous with the pharyngeal, and is surrounded by the *peristaphylini*, the action of which is believed to separate the walls of the aperture. Within the tube, and towards the tympanal end, this membrane parts with its pharyngeal spongy character, and becomes thin and semitransparent where it lines the bone. The same kind of membrane, partaking of the characters of periosteum and mucous, is continued over the tympanal cavity, and into the mastoid cells.

Muscle of the malleus and groove.

Above the Eustachian tube is a thin osseous plate, which separates it from a small canal, convex below, concave above, and which, commencing in the fissure between the squamous and pyramidal portions, terminates in the tympanal cavity. In this canal is lodged the internal muscle of the *malleus*, one of the tympanal bones.

Tympanal bones.

These are four in number, very minute, and denominated, from their mechanical figures, the hammer (*malleus*), the anvil (*incus*), the lenticular or round bone (*os orbiculare*), and the stirrup (*stapes*). Of these the *malleus* is attached to the vertical membrane by its handle, while its head is articulated with the body of the *incus*. The latter presents two limbs or branches, to the larger of which the *stapes* is articulated by the interposition of the lenticular bone; while the base of the former rests on the membrane of the *foramen ovale*. These articulations are secured by capsules, which allow the bones to move freely on each other; and for this purpose the *stapes* is provided with one muscle, and the *malleus* with two, an internal already mentioned, and an external passing from the spinous process of the sphenoid bone to the slender process of the *malleus*. On the motions of these, however, and their part in the process of hearing, we have only conjectural statements.

Foramen ovale, fenestra ovalis.

The internal bony wall of the tympanal cavity presents two apertures and a convex intermediate eminence. Of the apertures, the first, which is named the oval or vestibular aperture (*foramen ovale, fenestra ovalis*), is situate above, oval transversely, with its great diameter horizontal antero-posterior. It communicates with the vestibule, but is closed by a fine membrane, to which the base of the *stapes* is fixed, and for the insertion of which its margin is grooved. The oval aperture is bounded above by a round prominence, corresponding within to the Fallopian aqueduct, and below by a large convex eminence named the promontory (*promontorium*), which indicates the situation of the cavity named the vestibule. Before and above the promontory is the extremity of the thin osseous plate which separates the Eustachian tube from the canal of the internal muscle of the *malleus;* and behind is an oblique cavity, which is placed between the lower entrance of the mastoid cells and the pyramid. Below the promontory is the round or cochlear aperture (*foramen rotundum, fenestra rotunda*), trilateral in early life rather than round, and still preserving in the adult the tendency to this shape; smaller than the oval, and directed backwards and outwards. The round aperture is shut by a membrane, the direction of which is oblique to that of the tympanum, and one side of which is towards that cavity, while the other forms part of the *cochlea*.

Promontory.

Mastoid cells.

At the upper part of the tympanum is a triangular-shaped opening, which leads into a rough short canal, terminating in the mastoid cells. These are analogous to the cells of the ethmoid, sphenoid, and occipital bones. They are lined by fibro-mucous membrane, and their use is to afford a posterior sonorous apartment for the vibrations produced in the tympanal cavity.

Near this triangular opening is a small bony process named the pyramidal, in which is a canal for the fleshy part of the *stapedius*, while the tendon issues from its orifice. Near the base of the pyramidal process is the hole by which the nerve of the *tympanum* (*chorda tympani*) passes through the glenoid fissure.

Labyrinth

The labyrinth consists of the vestibule, three semicircular canals, and the *cochlea*.

Vestibule.

By removing the *stapes* and stapedial membrane the oval aperture is opened, and communicates with the vestibule. This cavity, which is irregular in shape, about the size of a grain of barley, is bounded without by the *tympanum*, within by the internal auditory canal, before by the *cochlea*, behind by the semicircular canals, and above and below by the solid bone of the pyramid. It is lined by a membrane common to the whole labyrinth. Besides the oval aperture by which it is separated from the *tympanum*, it has, above, the two anterior openings (*ampullulæ*) of the superior vertical and horizontal canals; behind, the two openings (*ampullulæ*) proper to the posterior vertical and horizontal canals, and the common opening of the

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two vertical canals; and before and below, the orifice of the external *scala cochleæ*.

Aqueduct of the vestibule and aperture.

There is still another aperture, which leads into a canal discovered by Cotugno, named the aqueduct of the vestibule. This, which, though distinct in some subjects, is almost imperceptible in others, is near the common orifice of the vertical canals; and from it the aqueduct proceeds first upwards, where it is narrow, then backwards and downwards, widening, and terminates in the fissure on the posterior surface of the pyramidal portion.

Semicircular canals.

The *semicircular canals*, situate behind the vestibule, are three in number, two vertical and one horizontal. Of the former, one is superior, inclosing by its curvature the substance of the pyramid, and forming a convexity in the adult, very distinct in the fœtus; while the other, which is posterior but inferior, is placed with its plane corresponding to that of the posterior surface of the pyramid. The third is placed horizontally between the other two, forming a curvature with the convexity towards the base of the pyramid. (Plate XXXIII. fig. 8, 9, and 10.)

Though denominated semicircular, these canals are larger than semicircular, and may be compared to hollow cylinders, incurvated so as to form large circular segments. Each canal has an enlarged extremity named *ampullula;* and as these two vertical canals have one in common, there are five *ampullulæ*. They are lined by the common labyrinthine membrane, and contain a pellucid fluid.

Cochlea.

The *cochlea*, which forms the third part of the labyrinth, is a conical canal turned spirally within itself, so that its base is at the lower part of the vestibule, and its apex at the anterior side of the pyramid, with the orifices for the auditory nerve inclosed in the centre of its turns, while the convexity is directed towards the lower margin of the pyramid. The cochlear canal is divided longitudinally by a thin sharp-edged plate, half bony half membranous, into two independent cavities, the superior of which communicates with the vestibule, while the inferior is bounded by the membrane of the round aperture. These cavities are distinguished as the vestibular and tympanal (*scala vestibuli* and *scala tympani*) respectively. At the top they terminate in a common cavity named the funnel (*infundibulum*). Both are lined by a delicate membrane, in which are contained the ramified filaments of the eighth or auditory nerve. (Plate XXXIII. fig. 10.)

Aqueduct of the cochlea.

In the tympanal *scala*, near the round hole, is a minute aperture leading to a narrow canal, which gradually enlarges as it ascends, till it terminates by a slit on the posterior surface of the pyramidal portion, as formerly mentioned. This is the aqueduct of the *cochlea*, first described, like that of the vestibule, by Cotugno.

Blood-vessels of the ear.

These different cavities are supplied with blood chiefly from minute branches of the auditory, a vessel generally derived from the basilar trunk or the vertebral arteries. From the meningeal artery also minute branches enter the auditory canal, and anastomose with those of the auditory artery; and the internal carotid sends to the membrane of the tympanal cavity a branch, the capillary ramifications of which anastomose with those derived from the pharyngeal, transmitted by the walls of the Eustachian tube.

Auditory nerve.

The eighth or the proper auditory nerve enters the cochlea by several minute apertures in the internal *meatus*, and is divided into two *fasciculi*, of which the posterior and largest is expanded in the form of soft pulpy brush-like filaments, like a hair-pencil, in a pellucid fluid, in the *cochlea;* while the smallest, which is anterior, is distributed partly to the bottom of the hemispherical cavity of the vestibule, partly to the beginning of the spiral lamina. (Fig. 10.)

The tympanal cavity is chiefly for the purpose of conveying and augmenting the intensity of sonorous vibrations, while the shape of the auricle is supposed to collect them. But of the mechanism of its operation we know nothing satisfactory. The essential part of the organ of hearing is the labyrinth.

SECT. IV.—THE ORGAN OF TASTE.

It is impossible to define the exact limits of the sense of taste. More or less diffused over the cavity of the mouth, it is particularly confined to the tongue and palate. The former, nevertheless, is remarkable for being a muscular organ, which combines with the faculty of taste the power of prehension and transmission of the alimentary articles both during and after mastication, and is further an essential agent in the faculty of articulation. It is requisite, therefore, to give a short account of the mouth, the palate, and the tongue.

The mouth.

a. The mouth is the cavity formed by the lips before, the *pharynx* and *isthmus faucium* behind, the palatine vault above, the intramaxillary membrane and muscles below, and on the sides by the cheeks. Its horizontal direction may be regarded as one among other proofs of the necessity of the erect biped attitude.

The mouth is lined by a mucous membrane, soft, spongy, red, and vascular. It may be traced from the inner or alveolar surface of the lips to the inner surface of the cheeks on each side over the gums, where it is continuous with that of the alveolar *folliculi*, over the inner surface of each maxillary *ramus*, and the attached muscles and glands below, until it is identified with that of the tongue, and above over the palatine vault back to the *uvula*. In these several points, though its organization is the same, its mechanical arrangement varies considerably as the parts are fixed or movable. Thus, on the palatine vault and at the gums it is tense, and adheres pretty firmly to the fibrous layers forming the periosteum of these parts. In the angular space between the lips and gums, however, in that between the inner surface of the alveolar arch, and all over the lower part of the mouth, where it is connected to the inferior surface of the tongue, it is extensive, loose, moves easily over an abundant layer of filamentous tissue, and is generally disposed in irregular folds. Adhering to the internal spine of the lower jaw, a fold or duplicature containing condensed filamentous tissue is reflected, to be attached to the median line of the tongue, and forms the *frenum* of that organ. In all points it abounds with muciparous follicles. It also presents on each side of the tongue the orifices of the sublingual glands.

Outlets of the mouth.

The mouth has two outlets, an anterior or facial formed by the lips (*labia*), and a posterior or pharyngeal formed by the *velum palatinum* and its appendages.

The lips.

The lips are musculo-membranous folds, attached all round to the superior and inferior jaw-bones, above and below the alveolar arches, and parted by a transverse opening or fissure into upper and lower, with right and left commissures or angles (*canthi*). In the Negro race they are particularly bulky and flaccid, with their free margins (*prolabia*) much everted; but in the Asio-European they are thinner, and more constricted.

Each lip consists externally of skin continuous with that of the face, internally of mucous membrane continuous with that of the mouth, with interposed filamentous tissue and muscles, well supplied by blood-vessels and nerves.

The point of union between the skin and oral mucous membrane is marked by a rounded edge, covered by a thin, vermilion-red, soft and delicate pellicle, extending between

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each *canthus*. This, which is sometimes named the lips proper (*labiola*), is the *prolabium*. The blood-vessels distributed to this part of the lips have an erectile arrangement. The marginal region of the lips between the skin and mucous membrane is occupied by the orbicular muscle. Above are the labial ends of the common levators (*levator labii superioris alæque nasi*), the proper levators (*levator labii superioris*), the small zygomatics (*zygomaticus minor*), and the naso-labial (*nasalis labii superioris*). Below are the two depressors of the lower lip. At the angles are placed the buccinators, the depressors of the angles, the canine muscle (*levator anguli oris*), and the large zygomatics.

The lips are supplied with blood from the branches of the external carotid. The external maxillary sends a large branch over the angle of the inferior jaw, upwards and forwards to the labial commissures on each side. This vessel, which is generally named the labial, sends off two, a superior and inferior labial, which are subdivided into numerous minute branches, anastomosing freely with each other, and with the submental and inferior dental branches. They open freely into the capillary veins, constituting a species of erectile tissue.

The lips derive their nerves partly from the superior maxillary, partly from the anterior or mental division of the inferior maxillary, with anastomotic communications from the 8th or facial nerve.

Soft palate.

b. The posterior or pharyngeal outlet of the mouth (*isthmus faucium*) is formed by the movable or soft palate (*velum palatinum*), a membranous fold attached to the posterior margin of the palatine quadrilateral bones, and hanging with its free margin downwards. This curtain, which has two surfaces, an anterior or oral and a posterior or pharygneal, is shaped like a double arch, meeting on the mesial plane, where it terminates in an elongated conical prominence, supposed to resemble a grape suspended by its stalk, and denominated therefore *uvula* (σταφυλη), but which, with the lateral arches, bears a closer resemblance to the descending cusp of a Gothic window. From this central process the arch rises on each side; and when it passes to the outer edge of the palate-bone on each side, it is supported by two musculo-membranous vertical columns, united at the top, but separating and forming an intermediate cavity, in which the tonsil on each side (*amygdala*) is contained.

The palatine curtain consists of two folds of mucous membrane, with interposed filamentous tissue and muscular fibres. The anterior mucous membrane is of the same character with that of the mouth, with which it is continuous. The posterior, which is continuous with the nasal mucous membrane, partakes of the characters of that tissue, and is redder and more vascular. These two meet in the lower margin of the *velum*, and pass into each other. Both are well supplied with mucous follicles, but the anterior or oral division most copiously.

These mucous membranes rest on filamentous tissue; and beneath this we find, in the middle, the *levator* or *azygos uvulæ*, and on the sides the levator of the soft palate (*peristaphylinus internus*), which are expanded in the *velum*. The anterior pillar consists of mucous membrane enveloping the fibres of the *constrictor isthmi faucium;* the posterior incloses those of the *pharyngo-staphylinus;* and both expanding into the *velum*, augment its thickness and regulate its motions.

Between the internal *peristaphylini*, which are immediately below the pituitary or posterior mucous membrane of the velum and the anterior, is an aponeurotic web, connected with the *circumflexi*, which, fixed to the margin of the palatine vault, tends to consolidate the *velum*.

The free margin of the *velum* forms the upper boundary of the posterior or pharyngeal opening of the mouth, while the upper surface of the base of the tongue forms the lower boundary. The size of this opening, which is usually named the isthmus of the throat (*isthmus faucium*), varies according to the state of the *velum* and its *uvula*. In the act of deglutition the *velum* and *uvula* are raised by the *peristaphylinus internus* and *azygos uvulæ*, and the whole curtain is constricted by the *constrictor isthmi faucium* and *pharyngo-staphylinus*. In the act of vomiting it is forcibly drawn up against the posterior nasal openings by these muscles; but notwithstanding this, matters from the stomach are occasionally projected through the nostrils. In singing on false notes the *uvula* is progressively elevated, as the voice ascends.

In the space between the anterior and posterior pillars are contained the tonsils (*tonsillæ, amygdalæ*), bounded above by the commissure of the pillars; below by the lateral part of the base of the tongue, where they are continuous with the muciparous glands of that organ; before by part of the *constrictor isthmi faucium;* and behind by the *pharyngo-staphylinus*. The shape varies in different individuals, though their pendulous attachment gives them the oblong spheroidal or almond-like shape. They consist of several lobules, grayish, soft, and of structure similar to that of the muciparous glands of the tongue. The lobules present minute cavities, isolated or mutually communicating, in the recess of which are minute pores, the orifices of the excretory ducts, and from which a watery but viscid liquor may be expressed. In short, each tonsil may be regarded as an assemblage of muciparous glands, destined to secrete fluid for lubricating the throat during the process of deglutition, when it is most abundant.

The chops (*buccæ*) or lateral walls of the mouth consist externally of skin, internally of mucous membrane and of an intermediate layer of muscles imbedded in abundant filamentous and adipose tissue.

The cutaneous covering is in general thin, soft, and peculiarly smooth, with a minutely distributed and abundant capillary system, which approaches in its characters to the erectile.

Beneath the cutaneous covering is the *zygomaticus major*, the only muscle proper to the cheek, resting on a thick layer of fat; below this is the *buccinator*, perforated by the parotid duct; and to the filamentous tissue inside, the buccal mucous membrane, furnished with numerous muciparous follicles, adheres. The orifice of the parotid duct is seen opposite the second molar tooth of the superior jaw.

The tongue.

c. The tongue is a longitudinal muscular organ, invested by a mucous membrane provided with numerous *papillæ*, attached behind to the hyoid bone, below to the mucous membrane of the mouth, and free above and before It is shaped like a flattened cone, and is distinguished into a base and tip (*apex*), an upper and a lower surface and two sides.

The base is somewhat thick and broad, but becomes thin and narrow near the hyoid bone. From about 1 inch anterior to this, however, to near 1½ from the tip, the thickness and breadth are nearly uniform. The tip (*apex*) is flat and rounded or paraboloid in ordinary circumstances, but may be made by muscular action to taper to an angular point. The upper surface, which is free, presents the lingual mucous membrane divided into right and left halves by a superficial furrow. On this, near its posterior end, is a depression, variable in size, named the *foramen cæcum*, in which are contained the orifices of muciparous follicles. From this on each side proceeds an oblique line diverging forward, and forming with that of the opposite side an acute angle, with the angular point behind. These an-

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gular ines, which are variable in shape and disposition, depend on the elevation resulting from the mucous glands at the base of the organ. The rest of the surface presents the minute conical eminences named *papillæ*, which belong to the mucous membrane. The lateral margins, which are smooth and void of *papillæ*, form the transition from the upper free papillated surface to the lower, which is chiefly attached by folds of the oral membrane to the lower region of the mouth.

The tongue consists of various muscles, connected by filamentous tissue, some adipose tissue, and invested by mucous membrane.

Muscles. The muscles are of two orders, those common to the tongue and contiguous parts, and those proper to the tongue. The common or extrinsic muscles are, the *styloglossi*, between the styloid process and margins of the tongue; the *hyoglossi*, between the branches of the hyoid bone and the margins of the tongue; and the *genioglossi*, from the upper internal mental tuberosities to the lower part of the organ. The proper or intrinsic muscle (*lingualis*) consists of two parallel layers of muscular fibres running along the lower surface of the organ, and a mass of fleshy fibres irregularly arranged and mutually crossing in all directions, and intermixed with a considerable quantity of soft but elastic oleo-adipose matter.

Of the lingual mucous membrane the most important circumstances are, the leathery thickness and distinctness of its corion and epidermis on the superior surface of the organ, and the papillary eminences with which it is marked.

Lingual papillæ. These *papillæ* may be distinguished into three orders; the irregular or granular at the base, the tubercular or rounded about the middle third, and the conical or pointed at the apex.

The granular *papillæ*, which vary in number from 10 to 15 or 16, are of a spheroidal or ovoidal shape, and are arranged on each side of the median furrow, obliquely behind the sides of the angle already mentioned. These bodies are evidently muciparous follicles; and it is in general easy to distinguish the orifice of the excretory duct by the eye or a moderate lens. They seem to receive filaments from the glosso-pharyngeal nerves, which enter the tongue immediately beneath these granular glands.

The tubercular *papillæ*, which are much more numerous, have rounded truncated summits, and occasionally pedunculated stalks. They are irregularly distributed towards the middle, margins, and apex of the tongue, promiscuously with the conical; and their nature is unknown.

The conical or acuminated *papillæ*, though occupying the two anterior thirds of the lingual surface, are nevertheless most numerous towards its apex, where they are also smallest, and somewhat inclined forward. These *papillæ* are asserted by the older anatomists to be the terminations of nervous twigs; and Cloquet allows them to be the expansion of the filaments of the lingual nerve. This, however, is an evident relic of the fanciful representations of the older anatomists, and is not supported by inspection. I have examined the structure of the lingual *papillæ* in many instances, and in none have I seen any ground for the assertion that they consist of nervous filaments. They do not even receive a larger proportion than other parts of the lingual membrane. The *papillæ* consist chiefly of numerous minute blood-vessels, rather tortuous, and communicating directly with veins enveloped in fine filamentous tissue; and from this they derive their property of erection, while their mucous surface secretes mucus copiously. These *papillæ* are further the seat of the white fur with which the tongue is liable to be coated in affections of the stomach. The yellow fur seems to be produced from the mucous surface generally.

Arteries. The tongue is supplied with blood by the lingual arteries, branches of the external carotids, and by the palatine and tonsillary of the external maxillary. The blood is returned by the superficial vein, the ranine, the lingual, and submental.

Nerves. The nerves of the tongue are derived from three different sources; the inferior maxillary, or third branch of the fifth pair; the glosso-pharyngeal; and the hypoglossal. From the first it receives the lingual nerve, which, after sending filaments to the sublingual gland, the *styloglossus*, *genioglossus*, and proper muscle of the tongue, is distributed chiefly to the upper surface, sides, and apex of the organ. This is believed to be the proper *gustatory nerve*. From the second it receives a lingual branch, which, passing between the *styloglossus* and *hyoglossus*, gives filaments to these, the proper muscle, and the posterior part of the *genioglossus*, and to the granular *papillæ*. By means of this nerve the motions of the tongue and pharynx are made to associate. The third, which is distributed chiefly to the muscles attached to the hyoid bone, sends filaments also to the *hyoglossus*, *styloglossus*, and chiefly to the *genioglossus*. The hypoglossal is believed chiefly to preside over the motions of the tongue, and probably those destined for articulation.

Uses. The tongue is one of the best examples in the human body, of the felicity with which a single organ may be adapted to a great variety of useful purposes. Endowed with the common sensation of tact, diffused over the body at large, its mucous investment is so organized that it recognises readily the peculiar impressions communicated by sapid bodies. To render it more serviceable in this respect, its muscles make it an organ of prehension, and elongate, contract, inflect, incurvate, or extend it, so as to apply objects placed on its tip to the palate or any part of the mouth. By the same means it becomes an important agent in the prehension of food, and in deglutition, by transmitting the masticated food to the pharynx. Lastly, it is a most essential and necessary organ of speech, and, by the nice motions which it undergoes, enables the human race to pronounce literal sounds and articulate consonants, which without its aid would be unutterable. Of this the letters l and r are examples.

Salivary glands. d. Connected with the organs of taste are the salivary glands, of which there are three pairs, one on each side of the mesial plane; the parotid, submaxillary, and sublingual.

Parotid. The parotid, so named from its situation before the ear, is the largest of all the salivary glands. It consists of two parts, the parotid proper, a large oblong mass placed in the deep angular cavity formed by the maxillary *ramus* and the mastoid process; and the *socia parotidis*, a large flat irregularly oval mass extending beneath the skin of the face. Partaking of the general characters of glandular structure, it is supplied with blood from the external carotid, by the temporal and transverse facial; its veins open into the external jugular; and it receives numerous nervous filaments from the facial and the ascending branches of the cervical plexus.

It has an excretory duct, named also the duct of Steno (*ductus Stenonianus*), which, quitting the surface of the gland a little above the middle of the upper margin of the *masseter*, proceeds horizontally over the tendinous part of that muscle, and, sinking into the filamentous adipose tissue of the cheek, perforates the *buccinator*, and terminates in the mouth at the level of the second superior molar tooth.

Sub-maxillary. The submaxillary or intramaxillary is smaller than the parotid. Oblong in shape, it is placed on the internal pit

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of the lower jaw, bounded by the internal pterygoid and mylo-hyoid above, the lingual nerve, the *stylo-glossus* and *hyo-glossus*, and the external maxillary artery behind, and below by the *latissimus colli* and integuments. Blood it derives from the lingual and external maxillary arteries, and nerves from the lingual and the myloid branch of the inferior dental. Its excretory duct, named, from its discoverer, *the duct of Wharton*, terminates on the side of the *frenum*, in a narrow tuberculated orifice.

The sublingual gland.

The sublingual gland is the smallest of the three. Parallel to that of the opposite side, it is separated from it by the base of the two *genio-glossi*, and rests on the *mylo-hyoideus*, which separates it from the intramaxillary. Occasionally, however, these two glands communicate by a slip from the intramaxillary below the muscle. It is supplied with blood by the sublingual, ranine, and submental arteries; and its nerves proceed from the lingual and hypoglossal. Its excretory ducts are manifold, and terminate either in several orifices on the sides of the *frenum*, or unite in a single tube, opening in the same region.

The use of these glands is to separate from the blood a watery but somewhat saline and sapid fluid, which has the twofold office of preserving the gustatory membrane in its necessary moisture, and of mixing with the food during mastication.

The *saliva* consists chiefly of water, holding in solution hydrochlorate of soda, sulpho-cyanic acid, and a minute portion of animal matter intermediate between albumen and osmazome. The presence of sulpho-cyanic acid, an active poison, is remarkable; nor is the purpose of such an agent known. From the saline matters in this fluid the tartar of the teeth is deposited; and occasionally minute concretions are formed in the glands or their ducts. That appearing in the ducts of the sublingual forms one variety of the affection named *ranula*.

CHAP. III.—THE ORGANS OF VOICE.

Voice is of two kinds, according as it consists in the mere voluntary utterance of sound, or what is named, in reference to the animal world, *cry*, or in the utterance of certain peculiar modifications of this, denominated therefore articulate voice, or simply speech. Inarticulate voice is common to all the MAMMALIA and BIRDS. By the possession of articulate speech, however, man (μεροψ) is particularly distinguished from the animal world in general.

These two forms of voice have two distinct organs. For inarticulate voice the *larynx* is placed at the superior extremity of the windpipe; and for that of speech, to the larynx are superadded the articulating powers of the teeth, lips, and tongue.

The larynx.

The larynx is a tubular organ, consisting of cartilages invested by membranes, connected by ligaments, and moved by muscles.

Thyroid cartilage.

The cartilages are five in number, the thyroid, cricoid, two arytenoid, and the epiglottis.

The thyroid cartilage, which forms the anterior and lateral region, consists of two lateral halves united on the mesial plane, where they form an acute salient angle, distinct beneath the integuments, and forming what is named the *pomum Adami*. The anterior surface is slightly concave, covered by the *thyro-hyoideus*, with an oblique line, to which the muscle now mentioned, the *sterno-thyroideus*, and inferior *constrictor*, are attached, and a posterior space covered by the two latter muscles. The posterior surface of the thyroid has in the middle a re-entrant angle, to which are attached the ligaments of the *glottis* and the *thyro-arytænoidei;* on the sides two plane surfaces, corresponding above to the cellular tissue of the *thyro-arytænoidei*, and below to the lateral *crico-arytænoidei*, and some fibres of the *crico-thyroidei* attached to this part.

Each lateral half is quadrilateral and quadrangular. To the upper margin, which is obliquely sinuated like an *f*, the thyro-hyoid membrane is attached. To the lower, which though shorter is also sinuated, the crico-thyroid membrane and the *crico-thyroidei* are attached.

The posterior margins, which are oblique and give attachment to several fibres of the *stylo-pharyngei* and *palato-pharyngei*, terminate above in an elevated pointed process incurvated inwards and forwards, connected by a ligament to the hyoid bone, and below in a similar process, shorter however and triangular in shape, and articulated by its tip with the lateral process of the cricoid cartilage.

Cricoid cartilage.

The cricoid or annular cartilage (κρικος, *annulus*), which occupies the lower part of the larynx, is a complete ring of cartilage, narrow before, and broad and elevated behind, where chiefly it constitutes the laryngeal cavity. Convex in the middle, where it is subcutaneous, it widens laterally where the *crico-thyroidei* are attached; and farther back, where it is covered by the thyroid cartilage, it presents the lateral process covered by synovial membrane for articulation with the triangular process of the thyroid. Its posterior region is broad and quadrilateral, with a ridge on the median line covered by the pharyngeal membrane only, and two depressions on each side, to which the posterior *crico-arytænoidei* are attached. The inner surface, which is concave, narrow before and broad behind, is covered by the laryngeal mucous membrane.

The superior margin presents before a large notch, to which the crico-thyroid membrane is fixed, laterally the insertion of the lateral *crico-arytænoidei*, and behind two convex surfaces, oblique in direction, covered by synovial membrane for articulation with the arytenoid cartilages, and between which this margin is covered by the arytenoid muscle. The lower margin, less irregular, descending before, sinuated on the sides and notched behind, is united by a fibro-mucous membrane to the first ring of the windpipe.

Arytenoid cartilages.

The arytenoid cartilages are two small bodies, triangular and pyramidal in shape, placed at the posterior part of the larynx, in the upper margin of the cricoid cartilage. In each arytenoid cartilage may be recognised a concave anterior surface for the arytenoid gland, a concave posterior surface for the arytenoid muscle, an internal surface covered by laryngeal mucous membrane, a base concave and oval, covered by synovial membrane for articulation with the cricoid, and a thin, convex summit, supporting a small cartilage (*cornicula laryngis*), invested by mucous membrane.

The tubercles of Santorini.

These bodies, which are named the tubercles of Santorini (*capitula arytænoidum*) by whom they were discovered, are conical in shape, with a concave base for articulating with the summit of each arytenoid cartilage, and a pointed *apex* incurvated inwards and backwards. To their surface, with part of the arytenoid, the thyro-arytenoid ligament is fixed, and forms the beginning of the *glottis*.

These bodies partake of the general characters of cartilage, and are invested by perichondrium. The thyroid and cricoid have a great tendency to ossification; and it is rare to find them unossified in advanced life.

The epiglottis.

The epiglottis is a thin slip of fibro-cartilage, of a paraboloid shape, covered by mucous membrane, attached at its base by cellular tissue to the inner surface of the hyoid bone and the upper margin of the thyroid cartilage, and by duplicatures of mucous membrane to the summits of the arytenoid cartilages. In this duplicature, on each side, is suspended a minute wedge-like cartilaginous tubercle, with the base upward, named the *cuneiform*.

The cuneiform cartilages.

These cartilages are articulated so as to admit of mo-

tion at the points already indicated. The articulations are secured by ligamentous capsules; but the most important ligament is the thyro-arytenoid, which passes from the base of each arytenoid cartilage to the re-entrant angle of the thyroid, where the fibres are mutually mixed with that of the opposite side. The thyroid moves on the cricoid, which may be regarded as the base of the organ; and the two arytenoid move on the upper margin of the cricoid. The epiglottis is depressed over the laryngeal opening by the motion of the tongue in deglutition.

The agents of motion in the larynx are of two kinds; 1*st*, those which move the whole organ in relation to the neighbouring parts; and, 2*dly*, those which move the component parts of the larynx in relation to each other. To the former class belong the sterno-thyroid, thyro-hyoid, and inferior constrictor muscles, with those attached to the hyoid bone, the elevation and depression of which the larynx follows. The second comprehends the crico-thyroid, the posterior crico-arytenoid, the lateral crico-arytenoid, the thyro-arytenoid, and the arytenoid. The connections and relations of these muscles it is superfluous to detail more minutely than may be understood from the description already given of the cartilages. It is sufficient to say, that while the crico-thyroid causes the thyroid cartilage to perform a swinging motion on the cricoid, the posterior crico-arytenoid draws the arytenoid cartilages back, the thyro-arytenoid draws them forwards, the lateral crico-arytenoid separates them from each other, and the arytenoid, sometimes distinguished into transverse and oblique arytenoid muscles, approximates these cartilages in different degrees, according to the act in which they are used.

The several parts now mentioned are invested on the inside by mucous membrane, continuous above with that of the pharynx and tongue, and below with that of the trachea. Proceeding from the former boundary, it may be traced over the epiglottis and its gland, on the mesial plane and the *thyro-arytænoidei*, and on the sides from the inner surface of the thyroid cartilage before to the outer margin and base of the arytenoid cartilages behind. At this part it rises to form two folds with rounded margins, extending from before backwards, and forming on the outsides a cavity with the arytenoid cartilage. These folds, though occasionally named the *superior ligaments* of the *glottis*, are truly mucous membrane doubled, with interposed filamentous tissue. They form an intermediate triangular space, with the base before and the apex behind. The inner surface of this membrane, directed to that of the opposite side, is concave, and forms a sort of pouch called the *ventricles* of the larynx (*sacculi laryngis*). The membrane here covers the thyro-arytenoid ligaments, over which it is tensely stretched, so as to form inferior folds, much tenser and firmer than the superior ones. These lower folds, which form a triangular interval with the base behind and the apex before, are the proper ligaments of the larynx, or vocal chords (*chordæ vocales*); and the intermediate fissure is named the *glottis*, or *rima glottidis*. Though this opening is triangular in the dead body, its shape varies much in the living. By the joint action of the posterior *crico-arytænoidei* and the *arytænoidei transversi*, the thyro-arytenoid ligaments may be rendered tense, the arytenoid cartilages approximated, and the fissure of the glottis become a mere slit.

Though it is impossible to adopt all the views of Dodart regarding the powers of the thyro-arytenoid ligaments, it is certain that their tension and relaxation, with the mutual approximation of the arytenoid cartilages, are the essential agents of voice. Without the air passing through the glottis there is no voice. The glottis is also the organ by which the quantity of air admitted into the *trachea* is regulated. By means of its muscles it may be shut, and the breath retained, so as to fix the chest during any great effort. By contracting it, also, during coughing or forcible expiration, the air is forcibly expelled from the lungs, and necessarily carries at the same time foreign bodies.

At the base of the epiglottis, in the angle between it and the thyroid, the laryngeal membrane presents several orifices, which may be traced to a cluster of follicles imbedded in the submucous tissue at this part. This cluster has been named the epiglottic gland.

A similar glandular body, in the anterior depression of each arytenoid cartilage, is named the arytenoid glands.

Of the body named thyroid gland, situate on the sides of the upper end of the *trachea*, and generally referred to the appendages of the larynx, nothing is known. With the larynx it has certainly no relation.

The blood-vessels of the larynx are the superior thyroid or laryngeal, the first branch of the external carotid, and the inferior laryngeal branch of the inferior thyroid, the second branch of the subclavian artery.

The nerves are derived from the pneumogastric or *nervus vagus*, and may be referred to three divisions; the *internal laryngeal*, distributed to the proper muscles of the larynx; the *external laryngeal*, distributed to the *thyro-pharyngeus*, the sterno-thyroid, hyothyroid, and crico-thyroid; and the *recurrent*, distributed to the laryngeal membrane. the thyro-arytenoid, and posterior crico-thyroid muscles. The division of these nerves, or of the pneumogastric, from which they proceed, is followed by palsy of the muscles, and inability to open the glottis at will, or retain it open; and the result is dyspnœa, terminating in asphyxia

CHAP. IV.—THE NERVOUS SYSTEM.

The nervous system includes two general divisions, a central and a distributed. The first is collected in a single and indivisible mass, contained in the cavities of the cranium and vertebral column, and may be designated by the general appellation of brain (*cerebrum*). The second consists of long chords connected with some part of the central portion and with each other, and distributed in every direction through the body in the mode of ramification. These are distinguished by the name of nervous chords or nerves (*nervi*).

SECT. I.—THE BRAIN AND ITS MEMBRANES.

§ 1. THE BRAIN. Plate XXX.

The brain may be considered as a continuous organ, consisting of three divisions;—the convoluted, the laminated, and the smooth or funicular portions. Of these divisions, which are framed according to the peculiar external configuration of each, the first part corresponds to what is called the brain proper (*cerebrum*); the second to the small brain (*cerebellum*); and the third to the oblong body contained in the vertebral column, and known under the name of *spinal chord*.

The convoluted portion presents two surfaces, an outer or convoluted, and an inner or figurate. The laminated portion in like manner presents two surfaces, an outer or laminated, and an inner or central. The third has only one exterior surface.

The shape of the first two divisions is like that of the cranial cavity in which they are contained, oblong spheroidal or ovoidal, with the small extremity of the ovoid before, and the large one behind.

The human brain is larger and heavier in proportion than that of any other animal. The three parts, the brain, cerebellum, and spinal chord, after being washed and

emptied of blood, weigh in the adult from two pounds five ounces to three pounds three ounces, and at an average about three pounds; and of this the brain alone weighs two pounds. The statement of Haller, that the brain weighs five pounds, is incredible, unless it be understood of Troy weight, in which case even it seems exaggerated, since of more than 200 brains weighed by Soemmering, not one amounted to four pounds. The statement, that the brain of Cromwell weighed six pounds and one fourth, seems equally incredible. The specific gravity of the adult brain is to water as 1031 to 1000. This, however, varies with age. The cerebellum weighs about five or six ounces, and is therefore about the seventh part only of the weight of the brain.

General division of the brain.

The brain (*cerebrum*) is divided above and before into two lateral halves, named hemispheres (*hemisphæria*), right and left, separated by a deep furrow, in which the vertical, crescentic, or dichotomous portion (*falx*) of the hard membrane is received. Each hemisphere is bounded by a superior or convex, an inner or plane, and an inferior convex and concave surface. The lower surface of each hemisphere, also, anatomists distinguish into three lobes, an anterior, posterior, and middle.

The cerebellum is also divided into two hemispheres, separated by a middle furrow of less depth, receiving, as that of the brain, a crescentic production, smaller in size, from the hard membrane.

Convoluted surface of the brain.

The exterior surface of the convoluted division is formed into eminences longitudinal and rounded, but directed in various ways, named convolutions or circumvolutions (*gyri*, Soemmering, Wenzel), and separated from each other by deep hollows (*sulci*). To see this surface, which is termed the *convoluted*, the vascular membrane termed *pia mater* (*meninx tenuis*) must be removed.

The convoluted surface of each hemisphere may be divided into five regions: 1. The commutual or dichotomous; 2. the lateral-superior or convex; 3. the antero-inferior or frontal; 4. the medio-inferior or spheno-temporal; and 5. the posterior or cerebellic region.

1. The *commutual,* plane, of a shape nearly semicircular, forms the mesial boundary of each hemisphere, and corresponds to the falciform or dichotomous portion of the hard membrane (*μηνιγξ σκληρα, meninx dura*), by which it is separated from the similar surface of the opposite hemisphere. Before and behind it extends from the superior to the inferior surface of the brain; but a considerable portion of its middle is terminated by the upper surface of the middle band (*mesolobe, corpus callosum*), which lies between the two hemispheres. It is contained between the semicircular and the rectilinear margins.

2. The *convex* region occupies the anterior, upper, lateral, and posterior parts of the hemisphere, from their anterior to their posterior extremity, and from the semicircular margin to a line which extends between these extremities along the lateral borders of the organ.

3. The *antero-inferior* or *frontal* rests on the horizontal part of the frontal and ethmoid bones, commencing before with a curved outline, bounded behind by the curvilinear hollow named the fissure of Sylvius, and at its inner or mesial margin by the great fissure which separates the hemispheres. This inner margin presents one convolution, consisting of a longitudinal eminence, extending in the adult brain about 1½ inch from the posterior towards the anterior end of the notch. The outer furrow contains the cerebral portion of the first pair or olfacient nerves. (1, 1.)

4. The *medio-inferior* or *spheno-temporal* is situate immediately behind this region, from which it is separated by the curvilinear hollow (*fossa Sylvii*). In the ordinary descriptions this forms the *middle lobe;* while the posterior part, corresponding to the *cerebellum,* though distinguished by no evident limit, is with equal impropriety named the *posterior lobe.* The whole region, from the curvilinear hollow to the posterior tip of the hemisphere, may, however, be subdivided into two, the *medio-inferior* and *postero-inferior* regions of the convoluted surface, according as they correspond to different containing parts.

5. The *posterior cerebellic region* of the convoluted surface, which is plane, corresponds to the horizontal or cerebellic part of the hard membrane.

The convoluted surface is formed of cerebral matter, of a gray or dirty wax colour, the surface of which is smooth and polished where it has not been rent by the removal of the membranes and their attachments. In the furrows are many minute orifices, into which the soft membrane (*λεπτη μηνιγξ, meninx tenuis, pia mater*) transmits filamentous bodies, containing minute blood-vessels.

Neither the eminences nor the hollows are uniform in number or distribution; and in no two brains is it possible to trace any similarity in their figure, presence, or direction, in the upper, lateral, and posterior part of the convoluted surface, unless where it approaches the central or figurate surface, where a number of important objects are presented.

The convoluted surface communicates with another interior surface at two parts; 1*st*, on the middle plane, under the posterior end of the middle band or mesolobe (*corpus callosum*); 2*d*, on each side of the middle plane, at the outer margin of the fluted masses termed *limbs* of the brain (*crura cerebri*), between these limbs and the posterior end of the optic chamber or couch (*thalamus opticus*). This surface of the organ may be termed the *central* or *figurate.*

Laminated surface of the cerebellum.

The exterior surface of the cerebellum consists of thin portions of cerebral substance named plates (*laminæ*), or leaves (*folia*), placed contiguously, either parallel or concentric, and separated by furrows of various depth. This surface, which may be named the *laminar* or *foliated* surface of the small brain, communicates also with the figurate surface,—1*st*, above on the middle plane, between the semilunar notch behind, and the white cerebral plate termed Vieussenian valve before; 2*d*, at its inferior surface, between the almonds or spinal lobules above, and the upper end (*medulla oblongata*) of the spinal chord below.

The outline of each hemispherical surface of the *cerebellum* describes three fourths of a circle; and as the segments mutually meet towards the mesial plane, the mode of union varies according to the figure of the objects to which they are adapted. 1*st*, The hemispherical border, approaching the anterior part of the organ, is suddenly interrupted where the cerebellic peduncles (*crura cerebelli*) are connected with the protuberance; and, pursuing a retrograde direction on each side towards the mesial plane, forms a re-entrant curvature or notch—the *semilunar*—corresponding to the lower pair of the bigeminous bodies.

Semilunar notch.

2*d*, The hemispherical borders, approaching the posterior part of the *cerebellum,* proceed, near the mesial plane, by an acute circular turn, almost straight backwards, and form, at the posterior edge of the organ, a deep rectangular notch,)(, not unlike the figure of the ancient lyre, named the *perpendicular fissure* of Malacarne, or *the purse-like fissure* of Reil, and containing the cerebellic vertical portion of the hard membrane (*falx cerebelli*).

Purse-like notch.

Between these two boundaries the cerebellic plates, of which the hemispheres consist, are united in the middle by an interlacement, named suture (*raphe*), of the cerebellum. A large hollow between the hemispheres, extending backwards from the semilunar to the purse-like fissure, is the small valley (*vallecula*) of Haller.

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Cerebellic lobes.

Each hemispherical surface consists of five lobes; 1. the anterior-upper or quadrilateral; 2. the posterior-upper; 3. the posterior-lower; 4. the slender, rarely exceeding three lines in breadth; 5. the two-bellied or biventral; and 6. the central lobe. The first two belong to the upper or flat hemispherical surface; the next three to the lower or convex hemispherical surface; and the sixth, common to the two hemispheres, is situate on the mesial plane of the upper surface, between the anterior end of the middle line (*raphe*) and the middle or apex of the semilunar fissure.

The tonsils.

The biventral lobe is pointed, and its margin concave; and between this margin and the parts of which the valley consists is placed a group of plates, convex and rounded, named the tonsil or tonsils (*tonsillæ; amygdalæ; the spinal lobule* of Gordon).

The flock.

In the angular hollow between the biventral lobe and the peduncle (*crus*) of the small brain, is the flock, a minute body, of irregular shape. Each flock consists of six or seven plates (*laminæ*), starting directly from the beginning of the peduncle, and with the concave margins directed towards the protuberance.

The pyramid, uvula, and nodule.

The valley is distinguished into three bodies, the *pyramid, uvula,* and *nodulus.* The first is a group of 20 parallel plates, with a triangular apex, bounded behind by the purse-shaped notch, and before by another cluster of plates called the *uvula.* The *uvula,* which is anterior, consists of twelve laminated leaves, is six lines long and four broad, and is smaller than the pyramid, and conical, with its base turned to that body. Lastly, anterior to the *uvula,* and separated from it by a furrow, is the laminar tubercle (*tuberculo laminoso*) or nodule, consisting of about ten thin transverse plates, the smallest in the row.

Central surface.

The second surface of the brain, in situation interior or central, may be named the *figurate* or *symmetrical.* Instead of presenting the uniform eminences and hollows which distinguish the convoluted surface, it is moulded into definite shapes, which correspond with each other, as they are situate on opposite sides of the middle plane,—or the parts of which, when situate on this plane, are exactly symmetrical. The surface formed by these figured objects bounds what are termed the *ventricles* or *cavities* of the brain. They cannot justly be termed cavities any more than the hollows between the convolutions, but ought to be viewed as continuations of the exterior or convoluted surface.

The central or figurate surface of the brain presents the following objects. The central band, beam, or mesolobe, a mass of white cerebral matter, uniting both hemispheres on the mesial plane, with the twainband or vault below; the *hippocampus major* on each side; the anterior pyriform eminence or striated body on each side; the posterior pyriform eminence or optic chamber on each side; the semicircular band on each side; the ergot on each side; the *conarium* on the mesial plane; the bigeminous eminences on the mesial plane; the valve on the mesial plane; and its pillars on each side.

Central band; corpus callosum.

The commutual or dichotomous region of the convoluted surface is terminated below by the upper surface of a white band uniting the two hemispheres. This, which was named by the ancient anatomists the smooth or polished body (*σωμα τιλλωδες, corpus læve*), to distinguish it from surfaces formed by a cutting instrument, appears in the form of white fibrous matter, passing transversely between the hemispheres, and marked by three longitudinal lines, one on the mesial plane, and one on each side. This is the *middle* or *central band* (*mesolobe* of Chaussier). Near its middle is a bundle of gray lines, which may be traced to the central portion of the *hippocampus major.*

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The posterior extremity of this body is rounded, and communicates with the chamber named third or middle ventricle. This surface is continued forward, and forms the vault or cieling (*fornix,* Die Zwillingsbinde, *the twainband,* Reil). The names of *callous body* and *vault* are used, as if they were denominations of different bodies. If they are still retained, it ought to be stated that they are names applied to opposite surfaces of the same object.

The triangular vault.

The relations of the posterior end of the middle band are as follow. The handle of a scalpel inserted beneath it is found to be in the middle ventricle, with the vault above, the *conarium* or pineal body, and four eminences of the upper surface of the protuberance (*corpora bigemina*) below, and a part of each optic chamber on each side. The vault or inferior surface of the band has the shape of an isosceles triangle, with the base behind. Before it is incurvated downward as it becomes narrow; and the space between the band and it is occupied by a thin double plate of cerebral matter, separating the two ventricles, and named the diaphanous partition (*septum lucidum*). (s, s, s.) The *fornix* terminates before, in two bodies named *anterior pillars.* (Fig. 3, F, F.)

The hippocampus major.

Superior lateral communication.

The posterior end of the middle band penetrates into the substance of the hemispheres; but the gray chords already noticed, pursuing their lateral course, are immediately enveloped in white plates derived from the sides of the vault, and assuming a cylindrical appearance, form, opposite the cerebral limbs, a body with a free rounded surface, which bends in a curvilinear direction laterally and downwards, and is the great *hippocampus* or cylindroid process. (Chaussier.) In observing this curvilinear course, it rests on and corresponds, but without adhesion, to the upper margin of the cerebral limb as it issues from the optic chamber; and the surfaces of both parts, though kept in apposition by vascular membrane, are free and unadherent. It forms *the great cerebral fissure* of Bichat.

The *hippocampus,* therefore, consists of two parts. The first, which is *the gray indented band* (*le corps godronnée,* Vicq-d'Azyr), is an inner or central portion, as thick as a large crow-quill, gray in colour, indented at the free edge, adhering to the cerebral substance by its opposite margin, and connected with the upper surface of the central band. The outer or second part, which is a broad thin plate of white cerebral matter folded over the gray indented band, as a map is rolled over a cylinder of wood, known under the name of the *tape* or *fringe* of the hippocampus, is connected with the lower surface of the same central band, or the vault (*fornix*) of the brain.

Inferior lateral communication.

At the inferior region the communication is effected by the curvilinear hollow. (Fig. 1, s, s.) This presents, 1*st,* cerebral substance, penetrated by numerous holes of various size, named the *white perforated substance* (*lamina perforata*); 2*dly,* the unconvoluted space; 3*dly,* the long cerebral band termed the *optic tract;* and, 4*thly,* the limb of the brain. This body, with that of the opposite side, is covered by a portion of the convoluted surface, the inner and prominent surface of the medio-inferior or spheno-temporal region.

The convoluted surface, which covers the anterior end and outer margin of the cerebral limb, when everted, presents the thin white body named the *tape* or *fringe* (*tænia*) of the hippocampus; and if the portion of convoluted brain next the curvilinear hollow be raised and everted in the same manner, the anterior end of this object, termed the *foot* (*pes hippocampi*), comes into view. The fringe of the hippocampus forms, in the natural position of the organ, the outer and lower border of the opening; while the limb of the brain, and the outer

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and lower surface of the optic chamber, form its inner border.

The striated eminences.

When the central surface is exposed by removing the central band and the vault and cieling of the ventricles, two pyriform eminences, an anterior and posterior, come into view. The anterior is ash-coloured or gray, inclining to wood-brown, with the round convex extremity before, and the small end tapering backwards and outwards, so as to inclose the round end of the posterior eminence. The surface is smooth and convex, consisting of a thin covering of gray cerebral matter. The interior consists of an admixture of white and gray, so as to form alternate streaks,—a circumstance from which these eminences on each side have been named the striated bodies (*corpora striata*). At their anterior mesial extremity are two rounded vertical bodies of white cerebral matter, descending from the anterior end of the vault. These are the anterior pillars, which are thus interposed between the interior front of the striated bodies.

Semicircular band.

The posterior and internal margin of the striated bodies is bounded by a gray, hard eminence, about a line broad, stretching with a sinuous or winding direction from its mesial and anterior to its external lateral and posterior margin. This is the semicircular fillet or band (*tænia semicircularis, centrum semicirculare geminum*). Always firmer than the neighbouring parts, it appears to be the external margin of a gray-coloured stratum or wall of cerebral matter between the anterior and posterior pyriform bodies.

Optic chamber.

Connected before and on the outside to the striated body by means of the double semicircular chord (*centrum semicirculare geminum*, Vieussens), each optic eminence presents four free surfaces—the upper, the inner, the posterior, and the lower. The upper is gently rounded, convex, and white in colour; its limits are not easily defined. The outer margin is bounded by the circular band, which even passes anterior to it, so as to form its boundary in that direction also. Behind, it is less distinctly limited, unless by the appearance of a considerable prominence, named the *posterior tubercle* of the optic couch.

Pineal gland and peduncles.

The inner margin of the upper surface is distinctly marked by a small, sharp, gray line, which, beginning insensibly at the anterior part of the body, becomes more distinct as it extends backwards, and ultimately bends towards the median plane. There it unites with a similar elevated line of the opposite optic eminence; and to the point of union is attached a small conical body with a minute point, of a gray colour, and of a shape like that of the pine-apple. This is the pineal gland (*glandula pinealis, conarium*); and the minute linear eminences which form the inner edge of the upper optic surface have been named *peduncles* of the pineal gland.

Soft commissure and third ventricle.

The inner surface of the optic couch or chamber presents the small portion of soft cerebral matter (*commissura mollis*) which unites it to the similar surface of the opposite body; and the intermediate space between the inner surfaces of these bodies on each side constitutes the third or middle ventricle (*ventriculus tertius*). Its posterior edge, however, is terminated by the cerebral limb of that side; and the lower edge meets that of the opposite one, and is connected to it by a portion of brain which forms the lower part of the middle ventricle, and corresponds on the outside to the *bridge of Tarin* (*pons Tarini*).

Geniculate tubercles.

The posterior surface of the optic chamber is convex and continuous with the unconvoluted space. Its most convex part presents two oblong roundish eminences, separated by a linear depression, which may be traced downwards with an outward curvature, and forwards about five or six lines, in a broad white band, crossing two fluted masses mutually converging behind at an angle. These eminences are the geniculate bodies (*corpus geniculatum externum et internum*), the outer the largest of the two (fig. 1, g, g); the white bands are the optic tracts or origins of the optic nerve, issuing from the geniculate tubercles (o, t); and the fluted converging masses are the limbs of the brain (*crura cerebri*).

Bigeminous eminences.

On the inner or mesial side of the geniculate bodies, and separated only by a linear furrow, are the bigeminous eminences, four orbicular elevations, two above and two below; two on each side of the mesial plane, with an intermediate cruciform furrow. By the ancients, who examined chiefly brute animals, the superior and larger pair were named *nates* (γλουτοι), the inferior *testes* (διδυμοι). These eminences occupy the upper surface of the protuberance, and partly that of the limbs of the brain; and while the eminences are situate between the posterior ends of the optic chambers above, the limbs appear to issue from the centre of these chambers below, and the linear furrow marks the point of junction.

Cerebral valve.

These bigeminal eminences, however, though occupying the superior surface of the protuberance, adhere not everywhere to its substance. (Fig. 3.) The mesial furrow is formed on the upper surface of a thin plate of white cerebral matter, which extends from the level of the pineal peduncles above, to the upper margin of the *cerebellum* below, like a veil, and is named the cerebral valve (*valvula Vieussenii*). The lower surface of this is free for about two or three lines broad; and, though applied to a similar surface on the mesial line of the upper region of the protuberance, does not adhere, but forms a canal with the third ventricle above and the fourth below, named the aqueduct of Sylvius (*iter a tertio ad quartum ventriculum*) (i). While the outer halves, therefore, of the eminences adhere to the matter of the protuberance, the inner are attached to that of the valve. (n, t.)

Pillars of the valve.

The lower or cerebellic margin of the valve is free, and overhangs as it were the fourth or cerebellic ventricle. On each side, however, is a longitudinal rounded body of white matter, which passes from the lower pair of bigeminous eminences (*testes*) to the cerebellum. These are named the pillars of the valve (*columnæ valvulæ Vieussenii, processus a cerebello ad testes*). The fourth or pathetic nerve (*trochlearis*) rises partly from the valve, partly from its lateral pillars, and is seen issuing on the sides of the protuberance not larger than a thread.

The lower surface of the optic chambers presents within the convoluted space the limbs of the brain (*crura cerebri*), two fluted semicylindrical masses, converging backwards, and inclosing by their junction a triangular space, with the apex behind—the *intercrural hollow*. The inner margin of the limbs presents the origin of the third or oculo-muscular nerves (*oculo-motorii*); about half an inch anterior on the intercrural hollow are the lenticular or pisiform bodies (*tubera, v. corpora candicantia*), two hemispherical tubercles of white matter; and immediately anterior is the *hypophysis* or pituitary gland, a broad quadrilateral reddish-gray prominence, with the anterior margin rounded, the posterior concave, inclosed before and on the sides by the converging optic tracts and commissure. (P.)

The limbs are obliquely crossed at their outer anterior end by the broad part of the optic tracts as they descend from the geniculate bodies. Their posterior convergent extremities are lost in the substance of the annular protuberance (*pons Varolii, nodus cerebri*), a convex rounded white body, with transverse *fasciculi* separated by linear furrows. (N.) Connected before with the *crura* or limbs, from which it is separated by transverse sinuous furrows, it is connected on the sides with the cerebellum by short semicylindrical stalks or peduncles (*crura cerebelli*), and

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behind with the beginning of the spinal chord (*medulla oblongata*). It is marked on the middle by a longitudinal furrow, in which is placed the basilar artery, the united trunk of the vertebrals. Its convexity corresponds to the concavity of the basilar groove of the occipital bone, on which it rests. This eminence may be regarded as the general central point of the cerebral nervous system, with which all the other parts are connected,—with the cerebral hemispheres by the *crura cerebri*, with the cerebellic hemispheres by the *crura cerebelli*, with the upper internal part of the optic chambers by the bigeminous eminences, and with the spinal chord by the *medulla oblongata*. From its anterior lateral margin the *tergeminal* or fifth nerve arises; from the posterior furrow the *abducent* or sixth nerve; and from the upper anterior margin of the cerebellic peduncle the eighth or lateral facial.

Head of the chord.

Continuous with and behind the protuberance is the beginning or bulb of the spinal chord, a part distinguished on the ground of an obsolete hypothesis by the name of *medulla oblongata*. Thick and prominent, its surface is moulded into six oblong-ovoidal eminences, three on each side of the mesial plane; the *pyriform* or *pyramidal* eminences before, the *restiform* bodies behind, and the *olivary* eminences on each side.

Pyramidal bodies.

The pyriform eminences (*corpora pyramidalia*) are two oblong-oval bodies, broad above, tapering below, separated by a mesial line, and bounded laterally by a furrow separating them from the olivary bodies, occupying the anterior-inferior part of the bulb of the chord, and resting on the lower third of the basilar groove. The mesial line terminates above in the *foramen cæcum* of the posterior furrow of the protuberance. (P.)

Olivary bodies.

The olivary (*corpora ovata*), placed on the outside of the pyramidal bodies, occupying partly the front, partly the side of the bulb, give it a lateral and transverse projection. In the intermediate furrow are the initial filaments of the *hypoglossal* or middle lingual nerve; and in the external furrow and sides those of the *glosso-pharyngeal* and *pneumogastric* nerves. (o, o.)

Restiform bodies and their groove.

The posterior-upper part of the *medulla oblongata* consists of two longitudinal cylindrical bodies, stretching between the cerebellic peduncles above and the spinal chord below. These are the *chordal processes* of Ridley, the *restiform* or rope-like processes of Morgagni, the *pyramidal bodies* of Haller, Malacarne, and Reil, and the *posterior pyramidal bodies* of Ruysch, Prochaska, and Soemmering. Above, where they are connected with the cerebellic peduncles, they are separated by a triangular space with the apex downward, but below by a deep furrow, the *calamus scriptorius* of the ancients, at the bottom of which, when separated, may be observed white chords proceeding from the process of one side, plaited with those of the other. These decussating fibres, which are confined entirely to the mesial margin of the restiform processes, are believed to establish a crossing connection between the right and left sides of the peduncles and the protuberance. The intermediate cavity is named the fourth ventricle. From the inner surface of the restiform process issue several of the initial filaments of the seventh or auditory nerve.

The spinal chord.

The spinal chord or funicular brain is a cylindrical body occupying the interior of the vertebral canal, from the margin of the occipital hole to the first lumbar *vertebra*; large and round on the cervical region, broad on the dorsal, and terminating in a brush-like expansion, denominated the *cauda equina*. On its dorsal surface may be seen a slightly depressed line continued from the middle furrow of the restiform bodies, but becoming faint and indistinct in the region of the back.

The central or figurate surface is smooth, polished, and possesses a degree of closeness of texture which prevents it from being readily abraded. These qualities are ascribed by Reil to a thin pellicle, which he terms *epithelia*. Though there is no proof of the existence of the covering, the term may be used to designate the smooth surface of the organ.

Of the central surface not only does every division mutually communicate, but the central surface of the convoluted communicates with that of the laminated part of the organ. The lateral divisions, named *ventricles*, communicate directly with each other below the vault, the surface of which lies over the *thalami;* both communicate with the third ventricle, which by the Sylvian aqueduct communicates with the fourth; and the posterior part of the lateral ventricle communicates with the digital cavity and inferior recess.

The central surface is covered by a vascular membrane (*plexus choroides*), continued from the *pia mater* of the convoluted surface.

Between the two surfaces now described is placed the proper matter of the brain, white and brown, which in different regions of the organ is differently arranged.

Structure.

The convoluted surface consists of a stratum of gray cerebral matter, arranged in the granular form. When indurated by immersion in alcohol or dilute nitric acid, it breaks with a small conchoidal fracture, occasionally uneven, and with an uneven granular surface, void of lustre and without fibrous arrangement. The only part of the convoluted surface presenting the latter appearance is the unciform band uniting the anterior and posterior lobes. (Fig. 5, v.)

Within the convoluted surface is contained a large quantity of white matter, surrounding the figurate surface and its divisions. The section of this, usually named the oval centre of Vieussenius (*centrum ovale*), shows merely the extent which this occupies in the upper part of the brain, but communicates no information on the intimate structure of the organ.

In intimate organization the brain may be distinguished into four parts; 1*st*, the brain, containing the striated *nucleus;* 2*d*, the cerebellum, containing the moriform body; 3*d*, the head or bulb of the chord, containing the moriform body; and, 4*th*, the annular protuberance as a central point of the whole.

The white fibrous matter of the central band, passing into the hemispheres on each side, diverges like the rods of a fan or the rays of a luminous body, and forms an arrangement denominated by Reil the *radiating crown*, and which may be regarded as the exterior investment of the *striated nucleus*, which constitutes the internal substance of the striated bodies and optic chambers. (Fig. 5, c.) The arrangement of white and gray matter in this part is so peculiar, that within the limits of this sketch it is impossible to convey a distinct idea of it. It may be stated in general that the fibrous matter of the limbs extends from the protuberance through the substance of the *thalamus* and part of the striated body; and while in this manner it maintains a connection between the protuberance and the brain above, by means of the cerebellic peduncles on the sides, and the head of the chord below, it communicates with the cerebellum and spinal chord behind and below. The moriform bodies (*corpora dentata, corpora ciliata, corpora rhomboidea*), which consist of white matter inclosed in a brown capsule, and the *cerebellic* and olivary eminences, are analogous to the striated nucleus of the brain; and the three may be regarded as the respective centres of each. The annular protuberance, consisting internally of transverse fibres closely interwoven with longitudinal ones, is the general or common centre of the three.

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The substance of the funicular or vertebral portion consists almost entirely of white fibrous matter, extending longitudinally from the cranial to the sacral extremity, but bending off laterally at the origins of the spinal nerves in the form of arches.

Blood-vessels.

The brain is supplied with blood by the internal carotid arteries and the two vertebral arteries, derived from the subclavian. The former, entering the cranium by the carotic canals, sends a *posterior communicating* branch, inosculating with the principal division of the basilar, and an *anterior communicating*, which joins the vessel of the opposite side. By these communications, the branches of the basilar artery behind, and the carotids before, form an arterial hexagon round the *sella Turcica*, from which arise two anterior vessels (*anteriores cerebri*), distributed to the central band, and two lateral (*mediæ*) or Sylvian arteries, distributed to the perforated spot, the Sylvian fissure and striated nucleus. The vertebral, entering by the occipital hole, send branches to the head of the spinal chord, and uniting to form the basilar, supply the protuberance and cerebellum; then divaricating into posterior cerebral, finally inosculate with the internal carotid to form the arterial hexagon as mentioned. The blood is returned by triangular canals named sinuses, of which there are the superior longitudinal, the inferior longitudinal, the cerebellic (*torcular Herophili*), the lateral, the circular, the superior petrous, the inferior petrous, and the cavernous. The four latter pairs are small sinuses opening into the lateral, where it emerges from the cranium by the temporo-occipital fissure (*foramen lacerum in base cranii posterius*).

§ 2. THE CEREBRAL INVESTMENTS OR MEMBRANES.

The brain is said to be surrounded by three membranous envelopes, the hard membrane (*meninx dura, dura mater*), the web-like membrane (*tunica arachnoidea*), and the soft or thin membrane (*meninx tenuis, pia mater*). To this arrangement, which has been adopted by almost all writers, there is perhaps no great objection. But it simplifies the subject, without misrepresenting, to refer them to two only; one of which, the hard membrane (*meninx dura, μηνιγξ σκληρη, dura mater*), is common to the brain with the inner surface of the scull; the other, the thin membrane (*meninx tenuis, μηνιγξ λεπτη, pia mater*), is proper to the brain only. They may be distinguished, therefore, by the terms *common membrane of the brain* and *proper membrane of the brain*. The arachnoid, again, is a pellucid web common to the cerebral membranes.

The dura mater.

The first of these, the common or hard cerebral membrane (*meninx dura, dura mater*), presents two surfaces, an outer or cranial and an inner or cerebral. The outer surface is irregular, filamentous, and vascular, and the substance of which it consists is distinctly fibrous. The fibres, however, do not follow any uniform direction, but are interwoven irregularly. Maceration causes this membrane to swell and become separated into fibrous threads. It is liberally supplied with blood-vessels, by which it is connected to the inner surface of the scull. No nerves or absorbents have been discovered in it. This outer or cranial surface of the *dura mater* is of the nature of periosteum. Its vessels may be traced into the inner table; it contributes to the formation of the cranial bones in the fœtus, and their nutrition during life.

The inner or cerebral surface of this membrane is smooth, polished, and shining; and, when examined in water, it appears to be formed by a very thin, transparent membrane, through which the cranial or outer surface and the fibrous structure of the hard membrane may be recognised. This pellucid inner membrane, generally termed the *inner lamina*, is the exterior division of the arachnoid membrane.

Vertebral sheath.

The *dura mater* is an extensive membrane, lining not only the interior surface of the scull, but, in a modified form, that of the whole vertebral column. The inner surface of each vertebra has a proper periosteum continuous with the periosteum of the outer surface; and from this issues a quantity of filamentous tissue, which penetrates directly a membranous canal, evidently of fibrous structure (*theca vertebralis*), tough and firm, but more delicate than the cranial *dura mater*. The *dura mater* in its course forms sundry prolongations; for instance, the large crescentic one named the *falx*, the horizontal one termed *tentorium*, and the small crescentic one named *falx minor* or *cerebelli*.

The pia mater.

The thin, soft, or immediate and proper cerebral membrane (*pia mater, meninx tenuis*) presents in like manner two surfaces, a smooth or cranial, which is exterior, and a filamentous or cerebral, which is interior and central.

The outer or smooth surface of the thin membrane (*pia mater*) has a glistening appearance, and is formed by a very thin transparent membrane, exactly similar to that which forms the cerebral surface of the *dura mater*. This surface, named in the ordinary works the web-like membrane (*tunica arachnoidea*), is believed to be a separate membrane from the *pia mater*; but that which forms the inner or cerebral surface of the *dura mater* has a claim equally strong to this distinction.

The inner or cerebral surface of the proper membrane is filamentous, flocculent, and sends out many angular filamentous processes, which, by numerous minute arteries and veins, communicate with the convoluted surface of the brain. These processes (*tomenta*) correspond to the furrows of the convoluted surface in which they are lodged. In detaching the membrane from this part of the brain, numerous vessels are drawn out of its substance; and when the membrane is injected these vessels may be seen distinctly filled, and communicating with the gray matter of the convoluted surface. The veins of this membrane may be traced to the sinuses. Neither nerves nor absorbents have yet been recognised in it. Bichat considers it to contain much cellular tissue, which, however, is denied by Gordon, who could not recognise it. The difference, however, consists merely in name. The *pia mater*, indeed, possesses no cellular tissue like the subcutaneous, the submucous, or the subserous. If, however, a portion of the arachnoid be peeled from it by careful management of the forceps and blowpipe, there is found a quantity of loose filamentous matter uniting this tissue to the fine web of the former. The existence of this tissue between the *pia mater* and arachnoid is further demonstrated by the phenomena of serous infiltration.

Distribution and configuration.

The *pia mater*, or proper membrane of the brain, consists of two parts, an outer, covering the *convoluted* surface of the brain, and an inner or central, entering the cavities formed by the inner, central, or figurate surface, and spread over this surface in the form of what has been termed the vascular or choroid web (*plexus choroides; tela choroidea*).

The continuity of the *pia mater* or exterior division of the proper cerebral membrane, with the choroid plexus or interior division, may be demonstrated in the following manner *First*, The *pia mater* may be traced behind and below the posterior extremity of the middle band (*σωμα τιλλοειδες, corpus callosum*, der balken), where it is continuous with the transverse web called *velum interpositum*, and which may be regarded as the first part of the central division. *Secondly*, From the situation of the *velum interpositum*, it may be traced forwards on both sides of the

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mesial plane into the lateral ventricles, spread over the surface of the optic *thalamus* and striated eminence in the form of the vascular web called *choroid plexus*, the right half of which communicates with the left by means of a similar slip of vascular membrane lying beneath the vault (*fornix*), and behind the anterior pillars of that body at the spot termed *foramen Monroianum*. *Thirdly*, It may be traced over the geniculate bodies and *thalami* into the posterior-inferior *cornu*, or sinuosity of the lateral ventricle, where it covers the *great hippocampus*. *Fourthly*, It may be traced at the angle between the *cerebellum* and *medulla oblongata*, or what is named the bottom of the fourth ventricle, where it forms a very minute choroid plexus, seldom noticed by anatomists, but not less distinct, and which may be traced up the fourth ventricle to be connected with the *velum interpositum* in the middle ventricle, and with the lateral portions of the hippocampus on each side. Each of the divisions of the choroid plexus now enumerated may be shown to be mutually connected, and to form parts of one general membrane, which again constitutes the inner or central division of the membrane of which the *pia mater* forms the exterior. Each division of the choroid plexus, in like manner, is connected, by means of minute blood-vessels, to the portion of the figurate cerebral surface on which it rests; and it appears to sustain vessels as the *pia mater* does to the convoluted surface.

In clear water the choroid plexus may be spread out, like the *pia mater*, in the shape of a thin semitransparent web, one surface of which is smooth, the other somewhat flocculent, and the substance of which is traversed by numerous minute vessels. The transparent web, which forms the basis of this membrane, is filamento-vascular; and its smooth free surface, a continuation of the arachnoid membrane, is smooth, polished, and thin, like silver paper.

The arachnoid membrane is common to the *dura mater*, *pia mater*, and choroid plexus. It covers the inner surface of the first membrane, to which it communicates its shining polished appearance, though the want of subjacent filamentous tissue causes it to adhere so firmly, that it cannot be readily demonstrated. After covering the free surface of the *pia mater*, it follows the course of that membrane into the central surface of the brain, and covers the upper or unadherent surface of the several divisions of the choroid plexus. For the demonstration of this fact we must be permitted to refer to Dr Craigie's *Elements of General Anatomy* (chap. xxiii. sect. 1), where the reader will find proofs, which the limits of this sketch do not allow us to adduce here.

From these it results that the arachnoid membrane possesses in arrangement and distribution a great resemblance to the serous membranes. It differs, nevertheless, in its extreme tenuity, in the closeness with which it adheres to the collateral tissues, and in its slight disposition to albuminous exudation. It appears to contain in its structure less filamentous tissue than the pure serous membranes.

The brain is developed from the branches of the internal carotid and vertebral arteries ramified through the vascular membrane (*pia mater*). Formation commences in two orders of vessels mutually directed to each other,—those of the convoluted surface (*pia mater*), and those of the central (*plexus choroides*). The central substance of each part is first deposited; and from these points deposition and moulding proceed to the two circumferences of the organ, The surfaces are therefore formed last; and the vessels gradually shrink as the process approaches to completion.

SECT. II.—THE DISTRIBUTED CHORDS; THE NERVES.

The nerves may be distinguished into classes according to the parts of the brain with which their cerebral ends are connected. On this principle they may be arranged in the following order.

The brain,	Olfactory,	1st pair.
	Optic,	2d pair.
The limbs,	Oculo-muscular,	3d pair.
Protuberance or its parts,	Trochlear (*nervus patheticus*), 4th pair.	
	Trifacial, 5th pair,	Ophthalmic branch. Superior maxillary. Inferior maxillary.
	Abducent,	6th pair.
	Auditory,	7th pair (*portio mollis*).
	Lateral-facial,	8th pair (*portio dura*).
Head of the chord,	Glosso-pharyngeal,	9th pair.
	Pneumogastric,	10th pair (*nervus vogus*,.
	Accessory,	11th pair.
	Hypoglossal,	12th pair.
Spinal chord,	1 Sub-occipital.	
	7 Cervical nerves.	
	12 Dorsal.	
	5 Lumbar.	

The spinal nerves are derived from anterior and posterior roots separated by the *ligamentum denticulatum*, a fibrous notched ligament, covered by arachnoid membrane. According to the researches of Charles Bell and Magendie, the anterior roots furnish motive filaments, and the posterior sensitive. The central connections of most of these nerves have been already mentioned; and their distributed connections have been, and will continue to be, incidentally noticed under the heads of the several organs. It is requisite, however, to notice shortly the relations and general distribution of several nervous chords which perform an important part in the functions of the animal body. These are the pneumogastric, the phrenic, and the great sympathetic or intercostal nerves.

Pneumogastric nerve.

The pneumogastric or *nervus vagus*, the 8th pair of the old nomenclature, the 10th in correct enumeration of the cerebral nerves, rising by various filaments from the furrow between the olivary bodies and the restiform, and from the posterior upper surface of the latter, emerges from the cranium with the jugular vein by the temporo-occipital hole. Here, closely united by filamentous tissue to the hypoglossal, spinal, and glosso-pharyngeal, it descends before the *rectus anticus* and *longus colli* on the outside of the carotid artery, though in the sheath with it, and before the subclavian artery on the right side, on the left before the carotid, enters the chest, where it enlarges in size considerably. (Plate XXXI. v, v.) In the chest it passes behind the *bronchi* in the posterior fold of the *pleura*, and is closely connected to the œsophagus in the shape of a thin cord. Both trunks, on reaching the cardiac end of this tube, pass with it through the diaphragmatic aperture, and are distributed to the stomach. In this course the pneumogastric nerve is divided into five orders of filaments.

1. In the neck it gives branches to the pharynx, and, communicating with the glosso-pharyngeal, forms the pharyngeal plexus, and furnishes a superior laryngeal branch, an external laryngeal, and an internal laryngeal, the latter chiefly to the intrinsic muscles of the larynx.

2. In the chest it sends off branches, which, communicating with those of the superior cervical ganglion, are distributed to the heart.

3. In the chest also it gives off the inferior laryngeal or recurrent nerve (r), which on the right side winding round the subclavian, on the left the arch of the aorta, reascends in the lateral furrow between the windpipe and *œsophagus*, and giving off cardiac, pulmonary, œsophageal, thyroid, and tracheal filaments. is finally distributed to the intrinsic muscles of the laryngeal cartilages. These multiplied connections tend to associate the motions of the glottis with the lungs, and to maintain a general consent between the pharynx, larynx, œsophagus, trachea, lungs, and heart.

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4. The pneumogastric trunk forms with the filaments of the inferior cervical ganglion the *anterior pulmonary plexus*, and alone it forms the *posterior pulmonary plexus*, which sends filaments to the lower part of the windpipe, the *bronchi*, the pulmonary artery and veins, and the *œsophagus*.

5. After passing the diaphragmatic aperture, the right pneumogastric trunk forms at the cardiac orifice of the stomach a plexus, from which filaments proceed to the *pylorus*, the gastro-hepatic artery, the right cœliac ganglion, the duodenum, the pancreas, the gall-bladder, and the liver, where it communicates freely with the cœliac ganglions. The pneumogastric of the left side is distributed chiefly to the pylorus and its arteries, and communicates freely with those of the right.

The phrenic nerve. The phrenic or diaphragmatic nerve, connected above with filaments of the pneumogastric, hypoglossal, second and third cervical nerves, and some branches of the brachial plexus, and occasionally with those of the great sympathetic, descends on the anterior and lateral part of the neck, between the *rectus anticus* and *scalenus anticus*, and enters the chest between the subclavian artery and vein. The right passes down on the surface of the right lung, beneath the pleura (φ, φ, Plate XXXI.); the left over the pericardium; and both are distributed chiefly to the diaphragm.

The great sympathetic or splanchnic nerve. The great sympathetic is much more complicated than either of these nerves. It cannot be said to originate from one part more than from another. Though connected with the brain by means of a communicating filament of the sixth pair, it certainly does not arise from that nerve: nor can it be said to arise from the spinal nerves, though connected with them on each side of the dorsal vertebræ. It appears more rational to regard it as a general and extensive network of nervous filaments, which establish a communication between different important organs. Connected above with three ganglions of the neck, the *superior*, *inferior*, and *middle cervical*, and by minute filaments with the lateral-facial, or eighth cerebral, pneumogastric, and glosso-pharyngeal, with which it contributes to form the pharyngeal plexus, it sends off the *nervi molles* or *superficial cardiac nerve*. Below the inferior cervical ganglion, generally regarded as a cardiac, the trunk enlarges, and furnishes filaments to the pulmonary and cardiac plexus, the former divided into right or anterior and left or posterior, and the latter into superior and inferior. About the seventh dorsal *vertebra*, after being connected with all the intercostal nerves and inferior thoracic ganglions, it forms the *splanchnic*, which, though only the abdominal part of the great sympathetic, may be regarded as a separate nerve. The constituent filaments of this nerve, after being united into two ganglions, the cœliac or semilunar, are resolved into plexiform arrangements, which surround all the principal arteries, and with them are lost in the substance of the organs. Thus the cœliac artery is inclosed by the cœliac plexus; and each of its divisions, the coronary or proper gastric and the gastro-hepatic and gastro-splenic, are inclosed in similar plexiform networks. In the same manner, the superior mesenteric, inferior mesenteric, and renal arteries, have each an appropriate plexus; and those of the colon, bladder, and uterus have small plexiform arrangements, which constitute parts of the same general system. In short, the great sympathetic or intercostal forms an independent nervous system of its own, and though not derived from the dorsal nerves, is intimately connected with them; and its distribution to the organs of digestion, of circulation, respiration, and secretion, is connected chiefly with the associated actions of these organs.

Our limits do not, however, admit of details; and the reader who wishes to understand the minute anatomical relations of these chords, will find the most accurate information in the fourth volume of the treatise of Soemmering (*De Corporis Humani Fabrica*, Trajecti ad Mœnum 1798); in the third of the Descriptive System of Bichat; and in the magnificent illustrations of Walter (*Tabulæ Nervorum Thoracis et Abdominis*, fol. Berolini, 1783) and Scarpa (*Tabulæ Neurologicæ*, fol. Ticini, 1794).

PART II.

ANATOMY OF THE ORGANS PERTAINING TO THE ENTROPHIC OR NUTRITIVE FUNCTIONS.

The growth of the animal body is effected, and its size and strength maintained, by a class of organs which may be named the *Entrophic* or *Nutritive*. These organs agree in the possession of certain common characters, by which they are distinguished from those of the functions of Relation.

The *first* common character is the want of symmetry in arrangement and harmony in action. Instead of being arranged on the median line, or with similar parts on each of its sides, the organ, or part of the organ, which is on one side, bears no resemblance to that which is on the other. Even in the case of the lungs, though there is a general resemblance, the left differs from the right not only in size and shape, but in the number of its lobes.

It must not be understood, nevertheless, that the organs of this class are altogether void of symmetrical figure. A plane may be made to divide the stomach even into similar halves, so as to leave on each side similar parts of the *cardia*, of the *pylorus;* and of the intermediate parts. This plane, however, corresponds not with the mesial plane, but passes transversely from left to right. Nearly the same rule is applicable to other organs.

The *second* general character of the entrophic organs is, that in action they are not under the influence of the will. The contractions of the muscular tissue of the stomach, and the secretion of its mucous surface, the peristaltic motion of the intestinal tube, the beats of the heart, and the action of the liver, are equally independent of volition. This character Bichat attempted in every instance to trace to independence on the influence of the brain and the cerebral nerves. In one sense this is a truism, in so far as it merely implies that the organs of the entrophic functions do not belong to those of relation. In another sense it is a gratuitous, if not a hypothetical assumption. Though the brain is evidently very intimately associated with the organs of the animal functions, it is not yet determined that it is entirely unconnected with those of the entrophic order. Serious lesion or injury of the brain or the protuberance operates as forcibly on the action of the heart as on that of the muscles of the extremities. On the whole, the safest mode of defining this character is merely to state the independence of the entrophic organs on the will.

Several of the organs of the entrophic function are nevertheless in some degree under the influence of the will. The lungs, for example, by being dilated only by the dilating agents of the chest, are within certain limits under the voluntary power. To this, however, a limit is fixed. Though inspiration or expiration may be effected at the will of the individual, or suspended for a little, very soon the accomplishment of these actions is no longer arbitrary. In like manner, though the bladder is evacuated by the voluntary effort of the individual, the stimulus by which the action is induced is involuntary altogether.

A *third* anatomical character common to the entrophic organs is, that all of them are situate in the interior of the

trunk, protected by those of the locomotive system; and that they are lined on one side by mucous membrane, continuous with the external integuments. By means of this arrangement, which is necessarily allied with their property of converting foreign into proper matter, all the entrophic organs, with the exception of the heart, communicate with the surface of the body.

A *fourth* anatomical character common to these organs is, that though continuous by their mucous investment with the outer surface of the body, their opposite, placed on the outside of the serous membranes, forms shut cavities, not communicating, unless in one instance—the peritoneal end of the oviduct in the female—with the external surface. Whatever be the intermediate substance, these organs are placed between the mucous and serous membranes.

The entrophic organs may be distinguished into two orders, according to the degree of the process performed by each. The nutritive function consists of two subordinate functions, the *limitrophic* or alimentary, and the *hæmatrophic* or circulatory; the first the preparation of the materials destined to be employed in nutrition; the second the distribution of these, after preparation, to the different regions and organs of the system. The organs by which the first process is accomplished constitute the first order; those by which the second is effected constitute the second order.

CHAP. I.—THE LIMITROPHIC ORGANS.

The limitrophic organs consist of two divisions; those for digestion of the food, or the chylopoietic, and those for absorption of its nutritious part. The former is effected in successive processes in the divisions of the alimentary canal, a tubular musculo-membranous apparatus, extending from the mouth to the anus. The second is accomplished by an assemblage of minute valvular tubes, the lacteals, terminating in the thoracic duct.

SECT. I.—THE ORGANS OF DIGESTION; THE CHYLOPOIETIC ORGANS.

The organs of mastication have been described already in the fourth section of the second chapter of Part First.

The pharynx.

The *pharynx*, placed on the median line, symmetrical and regular, occupying the upper part of the neck, makes a close approach to the organs of relation, and marks the transition from these to those of the entrophic function. Attached above to the cuneiform process of the occipital bone, behind to the cervical vertebræ, and with the nostrils, mouth, and larynx before, it forms an irregular vaulted apartment about four inches long and two broad at its widest part, and contracting below, where it is continuous with the *œsophagus*. Besides the opening into this tube, the *pharynx* presents six apertures; the pharyngeal apertures of the nostrils, the pharyngeal orifice of the mouth, the upper end of the larynx, and the pharyngeal apertures of the Eustachian tube.

It consists of a mucous membrane stretched over loose filamentous tissue inclosed by three muscles, the superior, inferior, and middle *constrictor*, and attached to the cuneiform process, the cervical vertebræ, and the lateral regions of the neck, by filamentous tissue.

By the superior laryngeal, the pharyngeal, the thyroid, the lingual, and palatine arteries, it receives blood, which is returned by a still greater number of veins to the external and internal jugular trunks. The nerves of the pharynx come from the glosso-pharyngeal, the hypoglossal, the pneumogastric, and the great sympathetic.

The œsophagus.

The *œsophagus* (*gula*) is a cylindrical musculo-membranous tube, communicating above with the pharynx, and below with the stomach. Placed above between the cervical vertebræ behind and the windpipe before, at the lower end of the larynx it inclines to the left, returns to the median line at the sternum, bends again to the left at the bifurcation of the trachea, and continues on the left side of the line, passing the aperture of the diaphragm, near the ninth dorsal *vertebra*, to its junction with the stomach. With the vertebral column behind, at its first inclination it covers the *longus colli* in the chest, crosses the *vena azygos* above, and covers the thoracic duct in the middle, and the aorta below. With the jugular veins and carotids on each side in the neck, below it has the *trachea* on the right, and the recurrent nerve and common carotid on the left; and in the chest it has the aorta on the left and behind. (Plate XXIX. fig. 2, c.)

Lined on the inside by a follicular mucous membrane which assumes longitudinal folds (*plicæ*), the œsophagus consists of two ranges of muscular fibres, the one transverse, the other longitudinal. The first are most distinct at the pharyngeal end. The second form a manifest thick layer through the whole extent of the tube. Externally is a quantity of filamentous tissue, connecting the tube to that of the mediastinum and adjoining parts.

The œsophagus is supplied with blood from the inferior thyroid, thymic, laryngeal, pharyngeal; the aorta by proper œsophageal arteries, the superior intercostals and bronchials, the pericardial, mediastinal, diaphragmatics, and even the coronary of the stomach. The blood is returned by veins equally numerous. The œsophageal nerves proceed from three different sources. Above, it receives filaments from the glosso-pharyngeal and pneumogastric, in the middle from the latter, and below from the pneumogastric and the great sympathetic.

The stomach.

The stomach (*ventriculus*) is a large pyriform musculo-membranous sac, incurvated on itself (Plate XXIX. fig. 2, and Plate XXXVI. fig. 4), situate in the epigastric and left hypochondriac regions, communicating above with the œsophagus, and below with the duodenum. Bounded above by the diaphragm, and the liver, which covers it, it has the spleen attached to its left great extremity, the transverse arch of the colon to the inferior large arch; and its posterior surface corresponds to the duodenum, pancreas, mesocolon, and large abdominal vessels.

The pyriform sac of the stomach is distinguished into a large end or sac (*fundus*), and a small extremity named the *pyloric*; while a particular incurvation of its direction gives it a large inferior arch (*arcus major*), and a small superior arch (*arcus minor*). At the left extremity of the latter is the *cardia*, the orifice by which the œsophagus enters the stomach (*osteum œsophageum*); and from this round the *fundus* is the large arch. A vertical plane drawn from the *cardia* divides the stomach into two portions,—the *cardiac* (*fundus*, *saccus cæcus*), and *pyloric*, terminating in an annular contracted opening, about an inch broad (*pylorus*, *ostium duodenale sive pyloricum*). Between the two arches is the *superior-anterior* surface, covered partly by the left lobe of the liver, partly by the left *rectus* and hypochondre, and the *inferior-posterior* surface behind.

Structure.

The stomach consists of peritoneum externally, mucous membrane internally, and an intermediate muscular layer with filamentous tissue.

The peritoneal covering is arranged in a peculiar manner. The anterior fold, meeting the posterior at the small arch, joins it, and forms a membranous production (*omentum gastro-hepaticum*), connecting the organ to the inferior surface of the liver, where they again separate to invest the upper and lower divisions of that organ. These folds, meeting in like manner along the large arch, where they form similar duplicatures, are again separated to in-

Special Anatomy.

close the spleen at the large end, and the colon along the lower division. In the triangular spaces formed by these duplicatures the gastric blood-vessels are lodged.

The mucous membrane, void of epidermis, is covered with minute piles (*villi*) from the cardiac, where they commence at the fringed termination of the œsophageal epidermis, to the pyloric, where they are continuous with those of the duodenum. It is further puckered into wrinkles (*rugæ*) or folds (*plicæ*), intersecting each other irregularly, and inclosing irregular quadrilateral spaces,—an effect produced by the contraction of the muscular coat, and connected with the great extent of the gastric villous membrane. In this also are contained follicular glands, especially at the pyloric end and along the two curvatures.

The muscular coat consists of two ranges of fibres, one longitudinal, following the great diameter from the *cardia* to the pyloric end; the other circular internal, inclosing the circumference of the organ, and most distinct when the organ is empty. On the latter depends the contracted incurvation of the stomach between the cardiac and pyloric divisions. (Plate XXXVI. fig. 4.) Besides these, there are on the left side of the cardia muscular slips expanded on the two surfaces.

Gastric vascular system.

The stomach derives its blood from the cœliac artery, the branches of which are arranged in a peculiar and beautiful manner. The cœliac divides into three vessels; one gastric proper, the *coronary;* one common to it and the liver, the *gastro-hepatic;* and one common to it and the spleen, the *gastro-splenic.* The first, the coronary, is distributed to the cardiac end, and, lodged in the peritoneal fold of the small arch, proceeds towards the *pylorus,* distributing branches before and behind. The second, after sending a large vessel to the liver, the hepatic, sends a small one (*arteria pylorica*), from the pyloric end, towards the gastric, by the superior peritoneal fold, to meet the terminal branches of the coronary; and a large one (*gastro-epiploica dextra*), by that of the large curvature, to meet the terminal branches of the left *gastro-epiploic.* The third or spleno-gastric artery, after transmitting a large vessel to the spleen, and various small vessels (*vasa brevia*) to the large *fundus,* sends a large vessel (*gastro-epiploica sinistra*), in the peritoneal fold of the large arch, to inosculate with the terminal branches of the right gastro-epiploic. The stomach is in this manner embraced, as it were, by arterial canals above and below. It is further remarkable, that while only one proper gastric artery, of inconsiderable size and limited distribution, proceeds from the cœliac trunk, the gastro-hepatic and gastro-splenic, each not much less than the cœliac itself, send their largest branches to the stomach, and proceeding from opposite ends of that organ, inclose it, meeting by inosculation in the middle of its great and small curvatures. From the capillaries at the *fundus,* chiefly the *vasa brevia,* the gastric fluid appears to be secreted. The blood, returned by corresponding veins, is poured into the portal.

The stomach receives nerves from the pneumogastric and the great sympathetic. In the stomach the alimentary mass is converted into the pulp named chyme.

The duodenum.

The *duodenum* (*ventriculus succenturiatus*), about twelve inches long in the human subject, is distinguished by being the most fixed part of the tube in situation. Placed on the vertebral column, and on each side in the cavity of the mesocolon, behind the stomach, and concealed by that organ, it is bounded above by the liver and gall-bladder, below by the pancreas and lower part of the mesocolon, and maintains the communication with the pyloric end of the stomach and the ileum. The duodenum is divided by two curvatures into three portions. The first, which is covered by peritoneum, extending from the pylorus to the site of the neck of the gall-bladder, horizontally backwards and a little to the right, descends about two inches almost perpendicularly. With this the second portion, forming an angle, ascends obliquely to the left, and terminates opposite the third lumbar *vertebra.* The third, forming an angle rather more than right, extends about two or three inches, and terminates at the peritoneal ring, about one inch on the left of the spine, where the ileum commences. The aperture of the common biliary duct, inclosed in a nipple-like process, and the pancreatic, are in the first portion. These curvatures are firmly connected by filamentous tissue; and the bowel retains them even after removal from the body.

The duodenum, void of peritoneal covering, consists externally of cellular tissue, inclosing a range of circular muscular fibres, and lined by villo-mucous membrane, arranged in numerous folds, or *valvulæ conniventes.* The duodenal arteries are derived chiefly from the gastro-hepatic, and are very generally pyloric twigs. This membrane is provided with follicles, first well described by Brunner.

In the duodenum, by admixture of the biliary and pancreatic fluids with the chyme, the latter is prepared for the separation of chyle, which, though more proper to the ileum, is begun nevertheless in this bowel. The comparative immobility of the bowel is requisite, both in consequence of the admixture now mentioned, and also of the fixed situation of the two glands by which the fluids are supplied.

The ileum.

The *ileum* (ειλεον) or small intestine (*intestinum tenue*), the longest part of the intestinal tube, extending generally from 28 to 30 feet, commences at the annular process above mentioned, and extends to the head of the colon, in which it opens in the right iliac region. It consists of a cylindrical musculo-membranous tube, surrounded by peritoneum, the two folds of which, meeting behind, attach it for the space of three or four inches to the vertebral column, and are again reflected laterally, as described in the first book of this treatise. This attaching membrane is named the mesentery. The great length of the tube, with the small extent of the mesentery, causes it to hang suspended in numerous turns or convolutions. By the ancients this intestine was distinguished into two parts, *jejunum* or the empty, and the *ileum* proper; and Winslow idly undertook to fix the limits of this division by referring the two upper thirds to the former, and the two lower to the latter. This distinction, however, for which there is no anatomical foundation, must be rejected as at once arbitrary and useless.

The muscular tunic consists of circular fibres entirely.

Structure.

The villo-mucous membrane presents numerous *valvulæ conniventes,* which increase its surface to at least double that of its proper area. These duplicatures are most numerous in the upper part of the tube, and diminish as they descend.

The villi

The mucous surface of the ileum is peculiar in presenting the piles or villosities in their most perfect form. When a portion of ileum is inverted, inflated, and immersed in pure water, an infinite number of minute processes are seen waving amidst the fluid; but a powerful glass does not enable the observer to determine whether they are round or flat, solid or hollow, obtuse or pointed. Of their shape and structure various accounts are given.

They were first represented, in 1721, by Helvetius, as cylindrical prominences in quadrupeds, but conical in the human subject. According to the microscopical observations of Lieberkuhn, each *villus* receives a minute lacteal tube, arterial branches, a vein, and a nerve; and in each the lacteal is expanded into a minute sac or bladder (*ampullula, vesicula*) like an egg, in the apex of which may be seen by the microscope a minute opening

Special Anatomy. The villi. On this sac the arterial branches are ramified to great delicacy, and terminate in minute veins, which then unite into one trunk; while its inner surface he represents as spongy and cellular. The space between the *villi*, which do not touch each other, he further represents to be occupied by the open orifices of follicles, so numerous that he counted eighty of them where were eighteen *villi;* and both, he asserts, are covered by a thin but tenacious membrane similar to epidermis.

Hewson, while he admits in each villus the ramification of minute arteries and veins, denies the saccular expansion, and infers that the lacteals are ramified in the same manner as the blood-vessels, and that the whole constitute a broad flat body, the spongy appearance of which he ascribes to the mutual ramification of the latter. With this in general Cruikshank agrees; while Sheldon, who found the *villi* not only round and cylindrical as Hewson, but bulbous as Lieberkuhn, and even sabre-shaped, rather confirms the statements of that anatomist. Mascagni and Soemmering, agreeing in the general fact of vascular and lacteal structure, seem to represent the shape of the *villus* as that of a mushroom, consisting of a stalk and a *pileus.*

Some of these discordant statements Hedwig attempts with equal ingenuity and industry to reconcile. The differences in shape he refers to differences in the animals examined; and in one class finds them cylindrical (*e. g.* in man and the horse); in another conical (the dog); in a third club-shaped (the pheasant); and in a fourth pointed or pyramidal (*e. g.* the mouse). The interior structure he also represents as spongy in all the animals which he examined; and invariably also he found at the apex the orifice of the duct, which, after the example of Lieberkuhn, he conceives constitutes the *ampullula.*

These conclusions are not exactly confirmed by the researches of Rudolphi, who examined the *villi* in man and a considerable number of animals. This anatomist never found the orifice seen by Hedwig, notwithstanding every care taken to distinguish it. He maintains that the *villi* are not alike in all parts of the intestinal canal of the same animal, as represented by Hedwig, but may be cylindrical in one part, club-shaped in another, and acuminated in a third. Admitting their vascular structure, which he thinks may be demonstrated, he regards the ampullular expansion as doubtful, and denies its cellular arrangement.

About the same time Bleuland, who had previously examined the intestinal mucous membrane, after successful injection of its capillaries, undertook to revive the leading circumstances of the description of Lieberkuhn. By examining microscopically well-injected portions of intestine, he shows that the *villi* are composed of a system of very minute arterial and venous capillaries, inclosing a lacteal, which constitutes the *ampulla*, and in the interior of which a certain order of these capillaries terminates. He also revives the statement of the absorbing orifice at the extremity of each *villus.*

According to the observations of Beclard, the intestinal *villi* appear neither conical, nor cylindrical, nor tubular, nor expanded at top, as described by several authors, but in the shape of leaflets or minute plates, so closely set that they form an abundant tufted pile. Their shape varies according to the manner in which they are examined, and according to the part. Those of the pyloric half of the stomach and *duodenum* are broader than long, and form minute plates; those of the *jejunum* are long and narrow, constituting piles; at the end of the *ileum* they become laminar, and in the colon are scarcely prominent. They are semitranslucent; their surface is smooth; and neither openings at their surface, in their cavity, or in their interior, nor vascular structure can be recognised.

Special Anatomy. Peyerian glands. The villo-mucous membrane of the *ileum* is provided with mucous follicles of two orders, the *glandulæ solitariæ* and the *glandulæ agminatæ;* the former, like granules, disseminated over the attached surface of the mucous membrane; the latter clustered in bodies at the anterior exterior part. They partake of the general characters of follicular structure.

The *ileum* is liberally supplied with blood by the superior mesenteric artery, the arrangement and distribution of which may be understood from fig. 4, Plate XXIX.

The nerves are derived from the solar *plexus.*

The colon. The colon, or large intestine (*intestinum crassum*), beginning in the right iliac region, extends round the folds of the abdominal cavity, inclosing the *ileum*, to the left iliac and pelvic, where it terminates in the *rectum.* Its length is from six to seven feet. The beginning (*caput cæcum*) is a round obtuse bowel, with a minute tubular process, varying in length, named the vermiform. The lower end of the ileum is inserted into the beginning of the colon laterally; and to the part below the insertion the name of *cæcum* or blind gut is restricted. From the *cæcum* the colon descends to the right hypochondre (*colon dextrum*), where it is connected at the hepatic flexure to the liver by the hepato-colic ligament, two folds of peritoneum, with intermediate filamentous tissue; between the right or hepatic flexure and the left or splenic it is distinguished as the transverse arch (*colon transversum*), attached to the large arch of the stomach by the gastro-colic margin of the *omentum;* an angular bend in the left hypochondre forms the splenic flexure; and, finally, after making a long sinuous alternating bend in the left iliac and pelvic regions, named the sigmoid flexure, it terminates in a portion comparatively straight (*το ευθυ, rectum*), and following only the antero-posterior incurvation of the inner surface of the sacrum, on which it is placed.

The colon is about two inches in diameter at an average.

The appearance of this intestine is intimately connected with its structure. Inclosed in peritoneum, by the posterior junction of which it is connected to the adjoining organs, it consists of a layer of circular fibres, intersected by three bands of longitudinal fibres. Both are asserted to be muscular; but perhaps the latter are more of the nature of aponeurosis, to give support and resistance to the action of the former. Whatever be their nature, however, they give the colon the appearance of being divided into transverse cells, separated by superficial partitions.

The mucous membrane of the colon possesses the villous character in the cæcum and right part, but loses it towards the lower part of the intestine. It is formed into large transverse folds or duplicatures, which separate the internal cells or compartments of the bowel.

The ileo-cæcal valve. At the insertion of the ileum into the colon the mucous membrane of each is prolonged with the submucous tissue, and they mutually meet in two crescentic processes, one superior, small (*plica superior, labium superius*), the other inferior, large (*plica inferior, labium inferius*), and approaching, by its greater prolongation, the paraboloid shape. The ileal side of both folds is concave, the cæcal or colic convex; and between their free margins, which are rounded, is an intermediate fissure, maintaining the communication between the two intestines. This arrangement, which is named the ileo-cæcal valve (*valvula Bauhini*, from its supposed discoverer), is supposed to allow the transit of alimentary and excremental matter from the ileum to the colon, but not in the converse direction.

The organization of the rectum is the same as that of the colon generally; but it is uncovered by peritoneum behind. Its lower extremity is surrounded by two circular ranges of muscular fibres, named the internal and ex-

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ternal sphincters. The lower fibres of the *levator ani* are inserted into its sides.

Vascular system.

The cæcum and right and transverse portions of the colon are supplied with blood from the superior mesenteric, by means of the *colic* arteries. The left iliac or sigmoid flexure receives vessels from the inferior mesenteric. The splenic part is supplied by vessels derived from the great anastomotic communication between the superior and inferior mesenterics. (Plate XXIX. fig. 4.) The *rectum* is copiously supplied with blood from three different sources. The first is the termination of the inferior mesenteric, which is contained between the folds of the *mesorectum*, under the name of *superior hemorrhoidal.* The second is the *middle hemorrhoidal*, or proper artery, derived from the hypogastric or posterior iliac. The third is the *internal pudic*, the lower or perineal branch of which supplies the sphincter with several branches on each side, distinguished by the name of *inferior hemorrhoidal* arteries.

The nerves are derived partly from the hypogastric plexus, partly from the sacral branches.

The rectum, like the pharynx, placed between the two classes of organs, entrophic and animal, belongs in some degree to both. As the termination of the alimentary canal, it belongs to the former; but by its sphincters and *levator* it pertains to the latter.

The appendages of the alimentary canal are two glands, the liver and pancreas, and a cellulo-vascular organ, the spleen

The liver.

The liver (*hepar, jecur*) is a large glandular organ, weighing from two to three pounds, situate in the right hypochondriac and epigastric regions, with the diaphragm above, and the hepatic flexure of the colon and the stomach below. It has a convex upper surface, a concave lower one, a posterior obtuse margin attached to the diaphragm by cellular tissue, and an anterior inferior acute one which is free. The lower surface is distinguished into right and left lobes by a middle pit (*sulcus umbilicalis, v. horizontalis*), in which the round ligament, the residue of the umbilical vein, is contained, and which is occasionally a canal by an arch of hepatic substance. The inferior surface of the left lobe is divided into anterior and posterior parts by a transverse furrow (*sulcus transversus, fossa transversa*), in which the trunk of the hepatic arteries, and the portal vein, and the hepatic ends of the biliary ducts, are contained. The margins of this furrow, which are elevated in the lower animals, were named gates by the ancients (*πυλαι, portæ*), from an erroneous theory. The posterior, which is most prominent, is distinguished by the name of small lobe of Spigelius (*lobulus Spigelii*). The other distinctions of this surface into *lobulus quadratus* and *lobulus caudatus* are immaterial. Between the anterior portal eminence and the umbilical *fossa* is an oval depression (*fovea cystica*), containing the gall bladder.

The liver is invested by peritoneum, the folds of which connect it to the neighbouring organs, and retain it in its place. Of these, the most important are the broad and coronary above, the lower or falciform below, and the gastro-hepatic duplicature between the liver and stomach. This forms the investment named *capsule* of Glisson, in which the portal veins are inclosed.

Structure and organization.

The structure of the liver is glandular. Two classes of vessels and a system of tubes are distributed in it; one ramifying into branches and minute tubes, the hepatic artery and portal vein; another, the hepatic veins, converging to a trunk, the *vena cava hepatica;* the third, the *pori biliarii*, converging into ducts terminating in the hepatic duct. From the researches of numerous anatomists, it appears that the hepatic artery, which is derived from the cœliac, and the portal vein, formed from the veins of the stomach, intestines, spleen, and pancreas, terminate in minute vessels mutually communicating. It appears further, that these capillaries communicate with those of the hepatic veins, and even the origins of the biliary pores; and Soemmering especially infers, that every hepatic *acinus* consists of hepatic artery, portal vein, hepatic vein, bile-pore, and lymphatic. From this, however, it does not altogether result that bile is secreted from the hepatic arterial blood. Each *acinus* may require a minute artery for nutrition, a portal venule for furnishing the materials of secretion, a duct for receiving the secreted product, and a vein for returning the residual blood.

The hepatic duct unites at an angle with the cystic, and forming the common duct, terminates in the duodenum. The gall bladder, which is a pyriform bag, with the *fundus* below and before, and a neck above and behind, acts as a receptacle for the bile when it is not required in the duodenum. The *fundus*, placed between the concave surface of the liver above, and the convex one of the pyloric division of the stomach below, may be compressed by that part of the organ when distended, so as to expel the bile from its cavity.

The pancreas.

The *pancreas* is a flat, oblong, glandular body, measuring from five to six inches in length, and weighing from three to five ounces, contained in the posterior epiploic cavity below the duodenum. It consists of lobules similar to those of the salivary glands. It has a proper artery, from which the pancreatic fluid, very similar to the salivary, is secreted, and conveyed into a small duct. The residual blood is conveyed by a proper vein to the portal.

The spleen.

The spleen (*lien*) is an oblong hemispheroidal organ, of a deep blue venous blood colour, varying in weight from 6 to 12 or 15 ounces, placed in the left hypochondre, between the *fundus* of the stomach and the left side of the diaphragm, with a plane surface applied to the former, and a convex to the latter part. The spleen is covered by peritoneum, which, doubling before, forms along the middle of the organ a gastro-splenic *omentum*, by which it is attached to the stomach. It is generally connected to the colon by a short peritoneal slip.

The intimate structure of the spleen is peculiar. It consists of a number of minute communicating compartments, separated by *septa*, with white granules intermixed These cells contain dark-coloured blood; and the organ is indeed more abundantly filled with this fluid than any other in the body. These cells appear to be of the nature of erectile vessels. The splenic artery is very large in proportion to the organ, and apparently communicates by minute terminations with veins, in which the blood is occasionally accumulated.

The principal use of the spleen appears to be, that it serves as a receptacle for a large quantity of blood, which accumulates in the splenic vessels, or flows into those of the stomach, as the latter organ requires. When the stomach is empty, it shrinks; and its blood-vessels, folded on themselves, neither require nor transmit so much of this fluid as they do when the organ is distended. In the latter case the vessels are stretched, their canals are rectified, and the blood flows freely through them. At this period the additional supply seems chiefly to be derived from the spleen. The splenic vessels also appear to contribute chiefly to the secretion of the gastric fluid, which is most abundant at the fundus of the organ.

SECT. II.—THE CHYLOPHOROUS VESSELS.

On the lacteals or intestinal lymphatics it is superfluous to add any thing to what is stated in Book I.

These vessels arise from the villous surface of the ileum, and proceeding between the folds of the mesentery, unite at the vertebral margin of that membranous duplicature, somewhere between the third lumbar vertebra and the aor-

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tic opening of the diaphragm. Here they terminate in a jointed irregular tube situate behind the aorta, and which, passing through the aortic opening of the diaphragm, proceeds through the chest between the artery and *vena azygos*, as high as the sixth, fifth, or fourth dorsal vertebra. Here it inclines to the left, and, passing behind the aortic arch and the left subclavian artery, winds to the left of the latter vessel, and, before the *longus colli*, ascends as high as the seventh or sixth cervical vertebra, where it terminates in the angle between the internal jugular and subclavian veins, in the trunk of these vessels. This is the *thoracic duct*. A similar vessel, though smaller, is found on the right side.

CHAP. II.—THE HEMATROPHIC ORGANS.

The organs of the hematrophic or circulating function consist of the heart as a central propelling agent, and of arteries and veins as distributing and reducent channels. The hematrophic organs may be distinguished into three orders; *first*, those of the general or nutritive circulating system; *secondly*, those of the aerating circulating system; and, *thirdly*, those of the secreting system. Of these the heart is the central agent; but in the mammalia and man it consists of two divisions, one pertaining to the general arterial, the other to the pulmonary or aerating system.

SECT. I.—THE ORGANS OF NUTRITIVE CIRCULATION.

§ 1. THE HEART AND HEART-PURSE.

The heart is a conical muscular organ, containing four communicating chambers, inclosed in a membranous sac, and situate in the anterior middle region of the thorax.

The pericardium. The inclosing sac, named heart-purse, or capsule of the heart (*pericardium*), consists of two portions or layers, an outer or proper capsular, and an inner or lining division. The outer or proper capsular part of the pericardium possesses the characters of a fibrous membrane, of some density and considerable strength. When washed, its colour is gray or grayish-white, and it appears to consist of minute fibrous threads, arranged without definite order. These fibres are most distinct at its lower margin, where it is connected to the circumference of the tendinous part of the diaphragm. In the young subject it is generally thin and translucent; in adult age or advanced life it is thicker and more opaque. This part of the pericardium is a mere investing membrane, which bounds the region containing the heart, but which extends no further. It embraces the origins of the large vessels above, adheres to the margins of the tendinous centre below, and is on each side connected with the pleura.

The inner surface of the pericardium has the appearance of a transparent or serous membrane, through which the fibres of the outer or capsular part may be seen, and which has the usual glistening aspect of such membranes. It is difficult, however, to insulate it from the outer layer, unless by boiling, when it may be peeled off in minute shreds.

Like the transparent membranes, this inner layer has neither beginning nor end, neither origin nor termination. After lining the inner surface of the proper capsule, it may be traced from the angle at which this capsule adheres to the large arteries and veins, over the auricles, and finally, over the outer surface of the ventricles to the apex of the heart.

In this course it preserves the characters of a thin transparent membrane, with a free surface, smooth, glistening, and moistened by a watery fluid; and an attached one, adhering on the one hand to the inner surface of the capsule, and on the other to the outer surface of the heart by means of fine filamentous tissue.

Injection shows that the pericardium consists chiefly of minute arteries and veins. The former are derived from the thymic, phrenic, bronchial, œsophageal, and coronaries of the heart. The substance of the capsular part is probably a modification of the white fibrous system. Nerves have not been traced to any part of this membrane; nor is it ascertained that it contains lymphatics.

Of a general conical shape, the heart (*cor*) is situate obliquely beneath and behind the sternum, with the base (*basis*) above and towards the right, and the tip (*apex*) pointing downwards, forwards, and towards the left. The axis of the cardiac cone lies at once obliquely from right to left and from behind forwards. (Plate XXXI.) The surface may be distinguished into two parts,—the anterior convex, appearing in the space between the right margin of the sternum and the sinuosity of the left lung; the posterior plane, resting chiefly on the oblique surface of the diaphragmatic tendinous centre. These two surfaces are united by a sharp anterior-inferior margin (*margo acuta*), and an obtuse posterior-superior one (*margo obtusa*). It generally corresponds in size with the fist of the individual; its average weight in the adult is about ten ounces; and its length from the middle of the base to the tip is about five inches. The heart.

The base of the heart is circular, flattened behind, and presents an oblique groove, which indicates the limits between the auricles and the ventricles.

Each auricle is of a tetrahedral shape, and is distinguished into the basilar or membranous part (*sinus venosus*), and the tip or proper auricle (*auricula*), a pyramidal angular process, the structure of which is muscular. The right auricle is the largest, the left smaller.

The ventricles constitute the great part of the cardiac cone. Their anterior and posterior surfaces present each a longitudinal depression (*sulcus longitudinalis superior et inferior*), proceeding from the base to the tip, containing the anterior and posterior coronary vessels, and indicating the situation of the fleshy partition (*septum ventriculorum*) common to both ventricles.

The interior of the right auricle behind presents above the opening of the superior *cava* (*ostium venosum superius*), below that of the inferior *cava* (*ostium venosum inferius*), larger, directed obliquely inward, with an intermediate eminence (*tuberculum Loweri*), denominated after Lower, and the Eustachian valve below (vol. ii. 794). Below and anteriorly is the opening into the ventricle, bounded by a round margin (*ostium inferius*); above is the tip presenting muscular bands (*musculi pectinati*); and within is the partition common to both auricles (*septum auricularum*), with an oval depression (*fossa ovalis*), the residue of the *foramen ovale*, occasionally bounded before by a crescentic slip of membrane.

The right ventricle (*ventriculus dexter vel pulmonalis*) is trilateral pyramidal in shape, with its base above corresponding to the inferior auricular aperture, its apex to that of the heart, the anterior-external wall corresponding with the anterior convex surface of the heart, and the posterior-internal with the common partition (*septum cordis*). It has two apertures—a right superior, communicating with the auricle; and a left superior, communicating with the pulmonary artery.

To the margin of the superior right aperture (*ostium auriculo-ventriculare dextrum*), which is round and thick, are attached several membranous triangular folds (*laciniæ*), with two, or occasionally three *apices*, to which are fixed tendinous chords (*chordæ tendineæ*), with their opposite extremities terminating in muscular cylinders (*musculi papillares, m. teretes*), connected with the fleshy walls of the ventricle. This membranous fold, though often composed of two triangular slips only, is denominated the

three-pointed or tricuspid valve (*valvula triglochin, v. tricuspidalis*). Its *apices* hang into the ventricular cavity, and are prevented by the tendinous chords and their muscular bands from being forced back into the auricle.

The left superior aperture (*ostium arteriæ pulmonalis*), corresponding to the beginning of the pulmonary artery which is attached to it, is placed behind the inner slip of the tricuspid valve, by which also it is covered. The inner margin of the pulmonary artery presents three crescentic or semilunar slips, named the sigmoid valves (*valvulæ sigmoideæ*), with their convex surface towards the ventricle, and the concave one towards the artery, and minute bodies at the middle (*noduli Morgagnii*), corresponding to the axis of the artery.

The interior of the left or posterior auricle presents on the right the two openings of the right pulmonary veins, on the left those of the left pulmonary veins, occasionally uniting in a single aperture, to the right and anteriorly the left surface of the *septum*, bounded before by a small semilunar slip, and below the aperture into the left or aortic ventricle.

The left ventricle has the shape of an obtuse cone, with its base above and behind, and its rounded apex behind and to the left. It is rather larger than the right. The basis has two apertures, a large posterior one, communicating with the auricle (*ostium auriculo-ventriculare sinistrum*); and a smaller anterior, opening into the *aorta* (*ostium aorticum*). To the ventricular margin of the former is attached an irregular membranous slip, not dissimilar to that of the right auriculo-ventricular opening, but always terminating in two apices, to which tendinous chords, connected with tapering muscular bands, are also attached. This has been denominated the bicuspid or mitral valve (*valvula mitralis*). Like the tricuspid, its *apices* hang into the ventricle, and are prevented from being retruded into the auricle by the tendinous chords and papillary muscles.

The aortic aperture, anterior and smaller, corresponds with the commencement of the aorta. Like the pulmonary aperture of the right auricle, it presents three semilunar valves, with the convex surface to the ventricle and the concave to the artery, and with central granules (*corpuscula Arantii*). These valves are occasionally distinguished into anterior, posterior, and inferior or lateral, according to their relation to the plane of the body. In their aortic side are generally small hollows, chiefly occasioned by distension of the aorta, named aortic sinuses.

The heart consists chiefly of muscular fibres, closely united by filamentous tissue, covered externally by the reflected or cardiac portion of the pericardium, and internally by a proper membrane.

Each auricle consists of two parts,—a membranous-muscular, arranged in the stratified mode (*fasciæ*), distinguished as the *sinus;* and a fasciculo-muscular, distinguished as the tip of the auricle, arranged in short parallel bundles (*funes*). The muscular walls of the left ventricle are more than double the thickness of the right; and while those of the latter collapse on division, those of the former retain their original disposition. The fleshy pillars of the interior of the right are small and slender compared with those of the left, which are thick and strong.

The arrangement of the muscular fibres of the heart, which has been studied by Senac, Wolff, Duncan, and Gerdy, is peculiar. Though mutually interlacing, like all the muscles of the entrophic order, the external are arranged in layers (*strata*), while the internal affect the fasciculated form. At the base they are incurvated round the basilar border, and wind obliquely towards the *apex;* but as they approach the latter region, more especially in the *septum*, they observe the longitudinal direction. The assertion of Soemmering, that they are distinguished as being connected without filamentous tissue, is inaccurate.

The adipose tissue at the surface, and towards the base and apex of the heart, appears to be useful in facilitating motion in an organ in incessant action, and forms a soft cushion for the cardiac arteries.

The inner membrane of the heart is thin and transparent. In the right auricle and ventricle, where it is continuous on the one hand with the inner venous membrane, on the other with the inner membrane of the pulmonary artery, it is evidently different from that in the left cavities. It is thinner, and more delicate and transparent. Covering every recess, it is doubled to form the different valvular productions. By Bichat it is believed to be identical with the inner venous membrane; but this is mere supposition. In the left cavities the inner membrane is thicker and more opaque than the right; and its valvular duplicatures, which are much thicker, approach to the fibro-cartilaginous character. This is particularly the case in the aortic sigmoid valves, which often in the healthy adult are firm and elastic, not unlike the palpebral fibro-cartilages. The supposition of Bichat, that it is identical with the inner arterial membrane, with which it is continuous, is, in regard to the ventricle, not improbable.

The heart is supplied with blood from the aorta by means of the right anterior or inferior, and the left superior or posterior coronary or cardiac arteries (*arteriæ cardiacæ*), both issuing from the aortic sinus immediately above the anterior and lateral sigmoid valves. The right or anterior coronary artery, lodged in the superior furrow, after sending several large branches to the *septum* and left ventricle, inosculates at the apex with a large branch of the left or posterior coronary. The latter, which is the largest of the two, after winding round the base of the heart towards the right, is recurvated at the thin margin to the posterior surface, where it runs in the posterior furrow, and is divided into two considerable branches, the larger of which is distributed to the apex; while the smaller, running transversely between the left auricle and ventricle, winds round to the obtuse border, and terminates at the apex, where all the three vessels inosculate freely. The blood is returned by corresponding veins to the coronary, which terminate by one aperture in the right auricle. Its nerves are derived from the pneumogastric and sympathetic.

The four chambers of the heart (*atria, atriola*) are distinguished into pairs,—a right auricle and ventricle communicating mutually and with the pulmonary artery, and a left auricle and ventricle communicating with the aorta. The auricles, separated by the common septum, do not communicate in the natural state; and though in many hearts an oblique opening exists at the anterior margin of the oval depression passing into the left, the crescentic membranous slip by which it is covered prevents the blood of the right auricle from communicating with that of the left. The ventricles are separated also by a thick, fleshy, common partition, through which there is no direct communication, though it was a favourite subject of inquiry before the time of Harvey, to discover communicating apertures.

Capacity of the cardiac chambers.

The capacity of these chambers varies. The right auricle is always more capacious than the left. The two ventricles are, as near as may be, of equal capacity; and the discordant results obtained on this point by numerous inquirers show merely that any variation is accidental or dependent on the state of the organ during the close of life. The blood found in the right ventricle after death varies from $1\frac{1}{2}$ ounce to 3 ounces. The capacity of the left, which is generally empty, is estimated by Meckel to vary from 8 to 20 drachms.

Course of the blood through the cardiac chambers.

The blood contained in the right chambers is modena-coloured or venous; that of the left chambers is scarlet-red or arterial. The former is derived from the *venæ cavæ*, which open into the right auricle; the latter from the pulmonary veins, which open into the left. The direction in which the blood flows on both sides is from the venous apertures into the auricles, thence to the ventricles, and thence to the respective arteries. The venous blood, on reaching the auricle, distends it, and impels its muscles to contraction; and the cavity thus diminished expels the blood in the only direction in which it can proceed,—by the aurico-ventricular aperture into the ventricle. This chamber being distended, its muscular walls all round, especially at the base, contract and diminish its cavity, when the blood, extruded, quits the ventricle in the only direction in which it can, viz. by the aperture of the pulmonary artery. The blood from the pulmonary veins follows the same course in the chambers of the left side. The blood of the ventricles is prevented from returning into the auricles partly by the tricuspid and mitral valves, but chiefly by the annular contraction of the auriculo-ventricular apertures, which are drawn from the margins towards the *septum;* while the latter is shortened, and the *apex* is made to approach the base.

§ 2. THE ARTERIES AND VEINS.

Connected with each ventricle is a large tube, in which the blood flows from the trunk to the branches. The pulmonary artery, the first of these, divaricates into a right and left branch, subdivided and distributed respectively to the right and left lung.

The aorta, which is the second, is the large artery which distributes the blood after aeration in the lungs to the system at large.

The *aorta*, rising from the left ventricle, after giving off the cardiac arteries, makes an antero-posterior incurvation with the convexity upwards, denominated the arch or curvature (*arcus aortæ*). (Plate XXXI. A, A.) From the upper side of this arch arise three large vessels, the *innominata* or subclavio-carotid, the common trunk of the right subclavian and carotid arteries (I), the left carotid (I), and the left subclavian. The aortic trunk, after this curvature, proceeds downward on the left margin of the dorsal vertebræ, giving œsophageal, bronchial, and superior intercostal arteries, thymic, pericardial, and inferior intercostal arteries successively. From the level of this arch to the parabolic opening of the diaphragm at the tenth dorsal vertebra, it is distinguished by the name of *thoracic aorta;* and below this, to the fourth lumbar vertebra, it is the *abdominal aorta*. At its transit through the parabolic aperture it sends off the diaphragmatic arteries.

The vessels issuing from the abdominal aorta may be distinguished into two orders, those which issue from its sides in pairs, and those which issue from its anterior surface singly only. The former consists of the *capsular*, distributed to the renal capsules; the *renal* or emulgent, to the kidneys; the *spermatic*, to the *testes;* and the *lumbar*, to the lumbar muscles, and that region generally. The latter are three in number only, the *cœliac*, *superior mesenteric*, and *inferior mesenteric*. Opposite the fifth lumbar *vertebra*, or the fibro-cartilage uniting the fourth and fifth, the aorta terminates by divaricating into two large lateral trunks, the common or primary iliacs (*iliacæ communes*); while from its middle behind proceeds a small *azygos* artery, distinguished as the *sacro-median*, along the median line of the *sacrum*. In this course the aorta is placed in the posterior angle of the thoracic and abdominal serous membranes, and, inclosed by the anterior vertebral filamentous tissue, sends from its posterior surface numerous arteries to the vertebral column and spinal chord.

The distribution of the branches of the aorta may be understood from the following tabular view.

- Common carotid.
  - External carotid.
    - Superior thyroid.
    - Pharyngeal.
    - Lingual.
    - External maxillary.
    - Occipital.
    - Post-auricular.
    - Temporal.
    - Internal maxillary.
  - Internal carotid.
    - Ophthalmic.
    - Posterior communicating.
    - Anterior cerebral.
    - Middle cerebral.
- Subclavian artery.
  - Subclavian portion.
    - Vertebral.
    - Inferior thyroid.
    - Suprascapular.
    - Transverse cervical.
    - Ascending cervical.
    - Deep cervical.
    - Internal mammary.
    - Superior intercostal.
  - Axillar portion.
    - External thoracic.
    - Infrascapular.
    - Circumflex humeral.
  - Brachial portion.
    - Deep humeral.
    - Anastomotics, or Articulars.
    - Radial.
      - Radial recurrent.
      - Superficial volar.
      - Dorso-radial of the thumb.
      - Dorso-radial of the fore finger.
      - Annular—deep arch.
    - Ulnar.
      - Ulnar recurrents.
      - Interosseal.
      - Nutritious.
      - Volar or palmar—superficial arch.
- Common iliac.
  - Posterior iliac or hypogastric.
    - Ileo-lumbar.
    - Sacral-lateral.
    - Obturator.
    - Gluteal.
    - Ischiatic.
    - Internal pudic.
    - Umbilical.
    - Vesical.
    - Middle hemorrhoidal.
    - Uterine.
    - Vaginal.
  - Anterior or external iliac.
    - Inguinal portion.
      - Epigastric.
      - Circumflex iliac.
    - Deep femoral.
      - Circumflex femoral.
      - Perforating.
    - Superficial femoral popliteal.
      - Superior articular.
      - Inferior articular.
      - Internal inferior circumflex.
      - External inferior circumflex.
      - Anterior tibial.
        - Dorsal of the foot. } Deep plantar arch.
      - Posterior tibial.
        - Internal plantar. } Deep plantar arch.
        - External plantar—superficial arch.
      - Peroneal.

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In general the denominations of these arteries indicate the parts to which they are distributed. In the ultimate distribution of the arterial system, however, there is great variety; and it is often impossible to determine the exact origin, course, and distribution of the smaller terminations. The trunks alone are constant in position. In distribution, the following general rules are observed:—1*st*, The arterial trunks send small lateral branches to the parts between which they run 2*dly*, The majority of individual organs are supplied, not by one proper vessel, but either by one principal artery and two or more subordinate ones, or by several subordinate ones. 3*dly*, A trunk, after giving off several lateral branches, may either terminate in one vessel, which is ultimately distributed to the organs to which it is destined; or it may divaricate into several, none of which may be considerable enough in size, or direct enough in course, to be regarded as the proper terminal vessel. Thus it is often difficult to determine whether the temporal artery or the internal maxillary is the continuation of the external carotid, which of the palmo-digital arteries is the continuation of the radial, whether the anterior or the posterior tibial artery is the continuation of the popliteal, and whether the dorsal of the foot is the termination of the former. 4*thly*, In the terminal vessels, where inosculation is frequent, it is impossible to determine whether an artery arises from one trunk or another. Thus in the arterial arches of the hand and foot, in which the digital vessels issue from the convexity of the arch, it is impossible to say whether these arteries arise from the radial or the ulnar in the one case, or the anterior or the posterior tibial in the other.

The arteries are accompanied by veins, which in general correspond, for the purpose of conveying the residual blood, after distribution, to the right chambers of the heart, to be transmitted by the pulmonary artery to the lungs for renovation. The veins of the head, chest, and superior extremities, open into the *superior cava;* those of the lower part of the trunk, the pelvis and pelvic extremities, terminate in the *inferior cava;* the veins of the stomach, intestinal canal, spleen, and pancreas, terminate in the portal vein; and the regredient hepatic veins are united in one vessel, which terminates in the upper end of the *inferior cava.*

SECT. II.—THE ORGANS OF AERATING CIRCULATION, OR RESPIRATION.

The lungs are two soft, spongy, vascular bodies, contained in the cavity of the chest, one on each side, and imitating in shape the internal figure of that region. Each lung, resembling somewhat a cone, with one side truncated, and the base obliquely cut, is distinguished into a convex external surface, corresponding to the concave internal one of the *thorax;* a flat inner or mesial surface, corresponding to the *mediastinum;* a rounded obtuse *apex*, corresponding to that of the *demithorax;* and a concave base directed obliquely from the mesial plane to the hypochondres, corresponding to the convex surface of the diaphragm.

Each lung is distinguished into lobes (*lobi*) separated by fissures (*incisuræ*). The right, which is the largest, consists in general of three lobes, the *superior*, *middle*, and *lower;* the left of two only, an *upper* and *lower*. The mesial margin of the left is distinguished from that of the right by a sinuous notch, indicating the situation of the heart (*fovea cardiaca*).

The intimate structure of these bodies, which has been the subject of much research, depends on the nature of the tubes which are distributed to them, and of which chiefly they consist. These are the bronchial or breath-tubes (*bronchi*), the continuations of the windpipe, and the branches of the pulmonary artery and veins.

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The windpipe (*trachea*) is a cylindrical tube, about four or five inches long, extending from the cricoid cartilage, to which it is attached by a fibro-mucous membrane behind the sternum, to the level of the third dorsal *vertebra*, or the fibro-cartilage between it and the second. (Plate XXXI. T.) It consists of from 17 to 18 or 20 cartilaginous rings (*annuli*), truncated behind, united by a fibrous membrane without, continuous, but particularly firm in the interannular spaces, and along the whole posterior part of the canal. These fibres are white, firm, longitudinal, and closely set. Within is the mucous membrane, continued from the larynx to the *bronchi*, resting on filamentous tissue, in which are embedded the mucous follicles. By many, muscular fibres have been represented to exist between the rings; according to Soemmering transversely and longitudinally; and Reisseissen has recently maintained their reality at the posterior part of the tube. Their fibrous disposition is undeniable, but their muscular character may be doubted.

The windpipe, covered before by the thyroid gland, and corresponding to the sigmoid pit of the sternum, is attached to the œsophagus behind by filamentous tissue.

Opposite the third dorsal vertebra the *trachea* is bifurcated into two tubes named air-tubes (*bronchi*), which are directed obliquely to each lung with a mutual intermediate angle of about 35°. The right is about one fourth larger and one fifth longer than the left. Both are cylindrical, but divaricate at their lower end, where they sink into the substance of the lungs, into several smaller tubes (*bronchia*), which again ramify and subdivide into tubes still smaller, and successively. The interbronchial angle is occupied by lymphatic glands, which are also arranged round the tubes.

The *bronchi* consist of cartilaginous rings, complete above, but parted into three annular segments between the middle and lower ends, united by whitish fibrous tissue, longitudinal externally, transverse within, and lined by mucous folliculated membrane. As they advance into the substance of the lungs, and are still more minutely divided, the cartilages diminish in size and firmness, and their place is supplied by fibrous tissue of transverse circular fibres, which at length also disappear, and mucous membrane alone is left.

These transverse annular fibres have been supposed by Haller, Soemmering, and recently Reisseissen, to be muscular. It is not improbable that they are so; but no positive proof of this fact has yet been adduced, and they appear rather to belong to the elastic fibrous system.

The larger bronchial tubes are accompanied each by an artery derived from the aorta or the subclavian, and following their ramifications into the pulmonic substance. The blood conveyed by these vessels is returned either to the *vena azygos* or the superior *cava.*

The pulmonic or final divisions of the bronchial tubes terminate in blind sacs covered by mucous membrane, and communicate with each other, forming an appearance of intersecting compartments, which have been distinguished by the name of *air-cells* (*cellulæ aereæ*), or pulmonic vesicles (*vesiculæ pulmonis*). They are represented as polygonal and irregular, and about one eighth or one tenth part of a line in diameter. (Haller and Soemmering.) On the whole, these air-cells appear to be merely the terminations of the bronchial tubes mutually communicating, lined by a very delicate mucous membrane.

The pulmonary artery, ramified and subdivided to a great degree of minuteness, communicates most freely with a number of vessels, which may be traced into trunks terminating in the pulmonary veins. This capillary system, enveloped in filamentous tissue, is distributed beneath the mucous membrane of the terminal bronchial tubes or communicating cells. The exterior surface of this filamentous tissue is covered by the *pleura.* From

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these facts it results that the lung consists of cartilaginous and fibrous tubes mutually intersecting, and the capillary communications of the pulmonary artery and veins, inveloped in filamentous tissue, lined on one side by mucous membrane, covered on the other by transparent serous membranes. The air-cells, lined by mucous membrane, have no communication with those of the filamentous tissue, as some have absurdly imagined. Except this filamentous tissue, the lung has no proper substance or *parenchyma;* and its structure is entirely filamento-vascular.

In the capillary vessels of the pulmonary artery and veins, the venous or modena blood, exposed to the influence of the inspired air through the thin bronchial membrane, parts with its dark, and gradually acquires a bright red tint. This may be styled the aerating or arterializing capillary system.

The lung, however, receives other vessels, the bronchials, by which its mucous aerating membrane and submucous tissue are nourished. Entering with the bronchial tubes between the folds of their *pleura*, these vessels are subdivided as they proceed, and at length form a minute network on the attached surface of the bronchial mucous membrane.

The lung derives its nerves from the eighth pair chiefly, and a few filaments from the great sympathetic. The lung is well supplied with lymphatics, both superficial and deep.

SECT. III.—THE ORGANS OF SECRETORY CIRCULATION, OR SECRETION.

Of the organs of secretory circulation, several, as the lacrymal gland, the salivary glands, the liver, and pancreas, have been already considered; and others, for example the *testes*, will fall under subsequent heads. This, however, is the proper place to notice the organs of the urinary secretion, which consist of two glands, the kidneys, and two excretory ducts, the ureters, terminating in a common receptacle, the bladder.

The kidneys.

The kidneys (*renes*) are two glandular bodies situate in the posterior or lumbar part of the abdominal region, one on each side of the lumbar vertebræ, behind the peritoneum, and before the *psoas* muscle and part of the diaphragm, with the *quadratus lumborum* behind and laterally, and enveloped in a thick layer of adipose tissue.

The right kidney is below the liver, above the cæcum, behind part of the duodenum, colon, and the right extremity of the pancreas. The left is bounded above by the spleen, by the transverse arch of the colon before, and it has the sigmoid flexure below. The right kidney is about two inches from the outer margin of the *vena cava*, and the left at about the same distance from the outer margin of the aorta.

The situation of the right kidney is generally lower than that of the left, so that part of its lower extremity is in the iliac *fossa*, while the lower extremity of the left is quite above the margin of the ilium.

Resembling in general shape the large French bean, named from it, each kidney may be described as an oblong body, convex externally and at both ends, and with a sinuosity at its inner margin, named the renal fissure (*fovea renis*), in which the vessels and excretory duct are contained. Each kidney is between four and five inches long, and two broad; and the weight of each varies from three to four ounces. The anterior surface, corresponding but not attached to the outer surface of the peritoneum, it convex, but becomes hollow at the inner margin, where it terminates in the renal fissure. The posterior surface, which is less convex, is separated from the internal aponeurosis of the transverse abdominal muscle, the diaphragm, and the *psoas magnus*, by a thick layer of adipose tissue.

The kidney consists of glandular structure, invested by a firm membrane, somewhat fibrous in appearance.

Structure.

In the glandular structure the anatomist recognises the most distinct example of this form of tissue. It consists of two parts, a granular external, and a tubular internal. The former, which occupies the exterior of the kidney, is a homogeneous substance, of a yellow fawn colour, and consists of minute spherical or spheroidal granules (*granula*), aggregated together by filamentous tissue, and forming at their exterior calycoid or cup-like cavities, in which the round *fundi* of the tubular conoids are lodged. In these the capillary vessels of the kidney are ramified with great minuteness. The tubular part consists of very minute capillary tubes (*tubuli uriniferi, tubuli Belliniani*), varying in length, united by filamentous tissue, and arranged in parallel juxtaposition, so as to form conoids with globular bases, which are lodged in the cup-like cavities of the granular portion, and rounded *apices* directed to the renal fissure. The number of these tubular cones varies from 10 or 12 to 18 or 20. Their apices form an equal number of nipple-like processes (*papillæ*), covered by a thin membrane almost transparent, in which are numerous minute holes, apertures of the tubes of which the cones are composed. These apertures, however, are much less numerous than the tubes, several of which are united in one common orifice. The renal *papillæ* thus constituted project into a series of conical cavities, formed within of the papillary membrane, without of fibrous *strata* and filamentous tissue. These cavities, which from their shape are denominated funnels (*infundibula, calyces*), uniting into three or four larger ones, terminate in a considerable membranous sac named the basin (*pelvis*) of the kidney.

These two parts of the kidney are distinguished not only in structure but in colour and consistence. While the granular part is fawn-coloured, and somewhat soft and flabby, the tubular is pink-red, fleshy and firm; and the boundary line is distinct. The tubular cones are separated from each other by partitions, which appear to be filamentous tissue.

There is no doubt that the granular is the secreting part of the gland; and the tubes are merely conduits of the urine, which indeed may be expressed from their apertures. It is important, however, to determine the mode in which the two portions communicate. The assertion of Ferrein and Eysenhardt, that the tubes are blind canals, is inaccurate in this respect, that the terminal tubes evidently communicate with others in the interior of the cones, which again are immediately connected with the granular part. It further appears, that in the granular part there are very minute white tortuous canals, which appear to communicate with the straight tubes of the cones. All beyond this is entirely conjectural.

The kidney, therefore, cannot be said to possess *parenchyma* or proper substance. The idle distinctions into cortical and medullary ought to be rejected as remnants of an exploded theory.

Blood-vessels.

The kidneys are supplied with blood from the aorta by the renal arteries. Issuing at right angles from the lateral regions of the abdominal aorta, below the superior mesenterics, these vessels pass directly into the fissure at its superior and anterior part, the left behind, the right occasionally before the renal vein, but crossing its direction. The calibre of these vessels is considerable, about three lines at least; and they have been estimated to convey the sixth part of the blood of the abdominal aorta. The left artery is about one inch long, the right is the whole breadth of the vertebral column longer. In the renal fissure each artery divaricates into three or four consider-

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able branches, which enter the kidney a little above the attachment of the basin (*pelvis*). These vessels are again subdivided into an anterior series before, and a posterior cluster behind the *infundibula*, which they accompany to the *papillæ*. Dividing more minutely, they form anastomotic arches, from the convexity of which proceed minute vessels, radiating into the granular substance of the gland. These vessels are distributed principally to the granular matter at its calycoid surfaces, in which the tubular cones are lodged.

The veins are arranged exactly in the same manner, and connected with the renal trunk, much as the arterial branches are connected with it.

The kidney is supplied with nerves, accompanying the arteries, derived from a plexus inclosing the renal trunk, and which is originally formed from filaments of the solar of the great sympathetic.

The basin or *pelvis*. The pelvis consists externally of a prolongation of the renal investment, a proper middle membrane, white, opaque, and fibrous, and an inner lining, which, though thin and semitransparent, presents the character of mucous membrane.

The upper extremity of each kidney is covered by the renal capsule, a substance of no peculiar structure, and the nature of which is unknown.

The ureters. The basin forms the common termination of the renal funnels, and the commencement of the ureter. This is a membranous tube, of the diameter of a moderate-sized quill, passing between the renal basin, behind the peritoneum, to the posterior and inferior part of the bladder, in which the lower extremity opens. Each ureter is inclined to the mesial plane below. The right ureter is on the outside, and nearly parallel with the inferior cavity. Both cross the *psoas* at an acute angle, and below the common iliac arteries and veins. In the pelvis they cross the *vas deferens* in the male, and on reaching the bladder pass obliquely, from eight lines to an inch, through its coats, and open in the posterior margin of the lower *fundus* of that organ.

These tubes consist of fibrous membrane, lined by mucous and covered by filamentous tissue. It contains no muscular fibres, notwithstanding the assertions of some.

The ureters are supplied with blood derived from the renals, occasionally from the lumbars and spermatics, but more especially from the aorta by two ureteric arteries.

The urinary bladder. The urinary bladder is a muscular membranous bag, spherical above and cubo-spherical below, placed on the lower region of the pelvis, behind the pubal symphysis, and before the *rectum* in the male, and the *uterus* in the female. From the peculiarity of its figure and relations, it is distinguished into a superior *fundus*, spheroidal, directed to the abdominal cavity; an inferior *fundus*, cubo-spheroidal, between the ureters and urethral opening; a neck (*cervix*), pyriform at the latter point; an anterior surface, corresponding to the posterior of the pubal symphysis; a posterior, corresponding to the rectum in the male and the uterus in the female; and lateral regions, corresponding to the ilio-ischial inner surface, and those of the *obturator internus* and *levator ani*.

In females generally the transverse extent of the bladder is greater than in the male, and in females after child-bearing than in the virgin. In infancy its superior fundus is pointed and conical rather than globular,—a peculiarity derived from its fœtal shape, which is pointed, with the *urachus*, a ligamentous chord proceeding to the navel, attached.

Structure. The bladder consists of a muscular coat, covered above, behind, and laterally by peritoneum, and lined by mucous membrane.

The peritoneal covering is continued from the anterior surface of the rectum, and the lateral regions of the pelvis over the posterior and lateral and part of the superior surfaces of the bladder, all of which are free; while the inferior *fundus*, the neck, and the anterior, are covered by filamentous tissue, connecting the organ to the neighbouring parts. This filamentous tissue is abundant, especially below.

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The muscular coat, always distinct, varies in thickness in different individuals. In females, so far as we have observed, it is rather thicker than in males. The fibres run in all directions, but are strong at the superior surface, where some anatomists have arbitrarily distinguished them by the name of *detrusor urinæ*. There are no fleshy pillars, mentioned by some, in the healthy state.

The neck is surrounded by a thick range of circular fibres, which has been denominated the *sphincter* of the bladder.

The mucous membrane, without *villi* or *epidermis*, is extended over the whole inner surface of the organ, and is continuous behind with that of the ureters, and before with that of the urethra. The space inclosed between these three orifices is named the vesical triangle (*trigonus vesicæ*); and a minute duplicature of the mucous membrane at the urethral orifice is denominated the *vesicæ uvula*.

The bladder is supplied with blood chiefly from the posterior iliac or hypogastric trunk, by means of the common pudic, the obturator, the ischiatic, and the hemorrhoidal. Of these, one vesical artery proceeds from the hemorrhoidal; another often comes off directly from the hypogastric as an inferior vesical; and in some instances they issue from the umbilical. The vesical nerves are partly from the sympathetic, partly from the sacral.

The capacity of the bladder varies in different individuals. In the female it is generally more capacious than in the male. In the healthy state it may contain a pound of urine, without extreme distension; and it is often capable of containing two, three, or four pounds. Its situation varies at different periods of life, and in different degrees of distension. In the fœtus and infant, when the pelvis is small, the bladder is contained in the abdomen. In the adult in the ordinary state it is within the limits of the pelvis; but when much distended, its superior *fundus*, rising above the *pubis*, is in the abdomen. During pregnancy, also, it is thrust forwards and upwards by the gravid womb.

Urine, the fluid secreted by the kidneys, is particularly distinguished by containing, with various saline substances, *urea*, an animal principle containing 46 per cent. of azote. As the saline ingredients also abound in principles containing this element, it may be inferred that the chief purpose of the kidneys is to remove from the system a considerable proportion of nitrogen, which would either be injurious by its presence, or disturb the due proportion of the other elements.

The urethra, which terminates the urinary apparatus, is nevertheless common to it with the reproductive organs. The male urethra especially is more connected with the reproductive than the secretory organs. In the female, in whom alone this canal is proper to the latter, it is a short muco-membranous tube, terminating in a papillated orifice in the superior anterior wall of the vagina.

PART III.

ANATOMY OF THE ORGANS PERTAINING TO THE REPRODUCTIVE FUNCTIONS.

These organs, by the possession of which the individuals of the human race are distinguished into two sexes, male and female, consist in the former of impregnating, and in the latter of the impregnable organs. The former may be again distinguished into preparing and transmitting

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organs; and the latter into receiving and ootrophic organs, or those which nourish the product of generation.

CHAP. I.—THE MALE OR IMPREGNATING ORGANS.

The male organs consist of two glandular organs, named testicles with excretory ducts, for secreting the impregnating fluid, and an organ for transmitting it to those of the female.

The testicles (*testes*) are two ovoidal bodies contained on each side of the mesial plane in a cutaneo-cellular sac named the *scrotum*, attached to the anterior inferior part of the pubal *symphysis*.

The scrotum.

The *scrotum* consists of skin with very thin corion, resting on loose filamentous tissue, which forms on the mesial plane a thick wall, separating the right half of the scrotal bag from the left. On the median line is a superficial groove, named suture (*raphe*), at which the corion and filamentous tissue, elsewhere loose, are united into a solid and firm substance. Most of the old anatomists mention a muscular layer known by the name of *dartos*, and to which they ascribe the contraction of the scrotum on exposure to cold; but the existence of this muscular layer is not supported by inspection. The scrotal skin is well supplied with arteries, and especially veins connected with those of the epigastric, external iliac, femoral, obturator, and external pudic, the branches of which anastomose freely. The nerves are from the lumbar, obturator, and crural.

The scrotal filamentous tissue incloses on each side a thin membranous sac of a pyriform shape, with the base below, and tapering to a neck above. Adherent on the outside to the filamentous substance, this membranous sac is free and smooth within, except at the neck, where it embraces a part distinguished by the name of spermatic chord. This, which is the sheath-like or vaginal coat (*tunica vaginalis*), is distinguished into two parts, an inferior pyriform, forming a cavity for the testicle, and a superior cylindrical, covering the spermatic chord, and adhering to it. This membrane is said to be fibrous externally; but it appears to be merely condensed filamentous tissue. Within it is evidently a transparent serous membrane, both in qualities and distribution. It is continued from the adherent part of the chord downward, and over the testicle.

The vaginal coat.

The albugineous coat.

Within the cavity of the former are contained the testicles, both suspended by the spermatic chord, with the *epididymis* behind. Their substance is inclosed in a firm, opaque, white, fibrous investment, covered by a thin transparent membrane, reflected from the vaginal coat. The former is the *tunica albuginea*, or proper tissue of the gland; the latter is the vaginal coat of the testicle (*tunica vaginalis testis*).

The testicle.

The testicle consists of minute irregular-shaped granules, of a white or gray-white colour, soft, closely compacted, and with numerous capillaries distributed through them. More minutely examined, these are found to be capillary tubes of extraordinary length, folded on themselves, and contorted so as to occupy a small space, and when unfolded extending, according to some anatomists, 16 feet, according to others to 25 or even 100 ells. These long tortuous tubes, which are named the seminiferous (*ductus seminiferi*), are estimated at about 300 in number. They communicate by one extremity with the blood-vessels and lymphatics of the testicle, and by the other, after several unite into one common duct, terminate in about 20 larger tubes, denominated egredient ducts (*vasa efferentia*), which, united in a cluster by means of filamentous tissue, and invested by part of the *tunica albuginea* form at the upper part of the gland a whitish cylindrical body, about six lines long and two broad, distinguished by the name of the process of Highmore (*corpus Highmori*). These efferent vessels unite and form a single tube of great length, which, folded on itself by innumerable turns, connected by filamentous tissue, and invested by *tunica albuginea*, constitutes the *epididymis*, attached by its *head* to the testicle, and by an incurvated extremity named *tail*, continuous with the common excretory duct (*vas deferens*).

The seminiferous tubes.

The process of Highmore.

The epididymis.

The vas deferens or seminal excretory duct.

The latter is a long fibro-cartilaginous tube, ascending upwards from the tail of the epididymis, and making part of the spermatic chord, with which it enters the abdomen at the inguinal aperture. At the inner margin of this it separates from the chord, and descends into the pelvis, first by the side, then at the posterior and inferior *fundus* of the bladder; and, approaching that of the opposite side with the *vesicula seminalis* on the outer margin, each *vas deferens* is in contact with the other at the base of the prostate gland. Here each receiving a tube from the corresponding *vesicula*, forms a common duct (*ductus ejaculans*), which traverses the prostate, and terminates in the urethra about one inch and a half from its vesical end, on each side of the eminence named *verumontanum*.

Spermatic chord.

The spermatic chord, by which the testicle is suspended, consists of the spermatic artery or its divisions, derived in general from the *aorta*, two or three spermatic veins, several lymphatics, and the *vas deferens*, inclosed in filamentous tissue, and covered by a slip of muscular fibres denominated the suspensory muscle (*cremaster*, *tunica erythroides*), detached partly from the internal oblique and transverse of the belly, fixed partly at the inner surface of the ligament of Poupart and the tuberosity of the pubis.

The spermatic artery divaricates into several branches, which are distributed, after a few sent to the *epididymis*, among the seminiferous ducts. They communicate with numerous tortuous veins, which are collected into a cluster known by the name of the *pampiniform body*, situate immediately below the *tunica albuginea*.

Seminal vesicles.

Below the inferior *fundus* of the bladder, on the outside of that organ, are placed two bodies, oblong, flattened, pyriform, with the base behind, composed at first sight of a series of cells separated by *septa*. Each of these bodies, which have been named the seminal vesicles (*vesiculæ seminales*), consists of a long tortuous membranous tube, convoluted on itself, and with the folds aggregated by bridles of filamentous tissue, which convert it into communicating sacs. The cavity of this canal, which communicates with the urethra by a tube, common to the vesicles and the *vasa deferentia*, has been supposed to serve as a reservoir for the seminal fluid after secretion by the testicles; but this supposition is by no means verified, and is open to several objections.

The transmitting organs consist of the *penis* with the urethra and prostate gland.

The cavernous body.

The *penis*, the shape of which is well known, consists, of two parts, the cavernous body (*corpus cavernosum*), and the spongy body (*corpus spongiosum*) containing the urethra. The cavernous body, single before, bifurcated behind, may be described as two cylindrical bodies, inclosed in a fibrous investment, which, uniting them on the mesial plane, forms a partition (*septum medium*), perforated nevertheless with orifices for vessels. The divaricating posterior extremities (*crura*) are firmly attached to the ischio-pubal *rami* on each side. The intermediate triangular interval is occupied by the perineal filamentous tissue, fat, the perineal muscles, and the spongy body in the middle. Above and before, both are connected to the pubal symphysis by a triangular, flat, fibrous substance, named the *triangular* or *suspensory ligament*.

The spongy body.

The spongy body is a cylindrical cellulo-vascular tube, inclosing the urethra, and occupying the middle depression, along the lower surface of the cavernous body, from its anterior extremity, where it constitutes the *glans*, to the angular bifurcation of the cavernous body, where it is expanded into a substance denominated the *bulb* of the urethra. The spongy body is invested on the side and below by integuments only.

Their structure.

Both these parts, but especially the cavernous body, consist of numerous minute arteries, communicating directly with elongated and dilatable veins, and constitute the best example of erectile arrangement in the body. The injection of these vessels constitutes the erection of the penis, and induces the contraction of the urethra necessary to expel the seminal fluid. The two extremities of the spongy body, the *glans* before and the bulb behind, form the limits of the erectile tissue round the urethra. The anterior extremity is covered by loose skin, which forms the foreskin (*præputium*), and, in the shape of a thin semi-mucous corion, provided with epidermis, is continued over the glans, from which it passes insensibly into the mucous membrane of the urethra.

With the penis several muscular organs are connected The *ischio-cavernosus* and *transversus perinæi* on each side connect the cavernous body to the *ischium;* and the *bulbo-cavernosus* connects it to the bulb of the *urethra.* Mr Houston of Dublin has lately discovered a packet of muscular fibres situate between the pubal arch and the penis on each side, which, by compressing the dorsal vein, may, he imagines, contribute to erect the organ.

The cavernous and spongy bodies are supplied with blood from the terminal end of the internal pudic artery, by means of two vessels, the *cavernous* and the *dorsal.* The bulb receives branches from the transverse perineal artery.

The prostate gland.

The prostate gland is a body cordiform or flat conoidal in shape, with the base behind and the apex before, corresponding to the vesical end of the urethra, situate behind the pubal symphysis before, and below the neck of the bladder, in the angle between it and the *rectum*, and between the *levator ani* of each side.

It is distinguished into three lobes,—two lateral, united on the mesial plane,—and a small cellulo-vascular slip in the angle between them, towards the base. In structure it is composed chiefly of minute arteries and veins ramified in a firm, fleshy, filamentous tissue, amidst which are placed follicles with minute ducts, which terminate in larger tubes, varying in number from seven to twelve, the apertures of which are on the sides and the surface of the urethra. These follicles secrete a viscid liquor, the use of which is unknown. From the fact, however, that, when the prostate gland is diseased or injured, the sexual appetite is languid or extinguished, it may be inferred that the prostate is essential to the generative functions in the male. It is analogous to the *uterus* in the female.

Cowper's glands.

With the prostate may be mentioned the accessory glands of Cowper, two small bodies, oblong-round, placed on each side of the urethra, before the prostate. They appear to be mucous follicles on the large scale.

The urethra.

The urethra is a membranous canal, extending from the neck of the bladder in the pelvis to the extremity of the glans, where it terminates on the surface by an aperture (*orificium urethræ*), consisting of two lateral segments. Its length and width vary in the erect and unerected state of the penis. In the latter it is about seven or eight inches long, and its calibre is about three lines, but admitting of distension beyond this. According to the parts with which it is connected, it is distinguished into four different portions; 1*st*, the *prostatic*, about one inch; 2*d*, the *membranous*, from one to one inch and a half; 3*d*, the *bulbous*, scarcely one inch; and, 4*th*, the *spongy* portion, occupying the anterior part of the canal, inclosed by the spongy body.

The surface of the urethra is a mucous membrane supplied with follicles, and moulded into blind sacs named *lacunæ*, which appear to contain mucous ducts. Its capacity varies in different parts. Wide at the middle of the prostate, it is contracted in the membranous part, which is indeed the narrowest of the canal; it enlarges again in the bulb; and from this it preserves the same diameter to immediately behind the *glans*, where it forms a dilatation distinguished by the name of the navicular (*fossa navicularis*). The apertures in this canal have been already mentioned to be, besides that of the bladder, one ejaculatory on each side of the *veru-montanum*, from seven to ten excretory apertures from the prostatic ducts, and one aperture from each accessory gland. The mucous membrane of the membranous and spongy portions presents longitudinal folds, which appear to be connected with the occasional distensions of the tube for the expulsion of the urine.

The urethra, straight in direction on the mesial plane, is incurvated within the pelvis from behind forwards, so that its concave incurvation incloses the pubal arch, while its convexity is turned to the perinæum. The pendulous state of the *penis*, when unerected, causes it to acquire another incurvation without the pelvis, with the convexity directed upward. These curvatures are considerably exaggerated in engravings. The first round the arch of the pubis is much less angular than it is delineated.

CHAP. II.—THE FEMALE OR OOTROPHIC ORGANS.

The female generative organs consist of the ovaries, the uterine or Fallopian tubes, the womb, and the vagina. These organs are contained in the pelvis.

The ovaries.

From the time of Steno, anatomists have given the name of ovaries or eggbeds (*ovaria*) to two ovoidal bodies, about the size of a pigeon's egg, placed one on each side of the womb in the pelvis, in a duplicature of peritoneum termed the broad ligament (*ligamentum latum*) of the *uterus*. Convex and free on their anterior and posterior surfaces, and tapering towards each extremity, their lower margin is straight or slightly concave, with a vascular sinuosity. The external extremity is contiguous to a round solid chord (*ligamentum teres*), forming the anterior margin of the broad ligament, and proceeding from the womb to the internal orifice of the inguinal canal and the pubal extremity of the ligament of Poupart, and by which the uterus is retained in the pelvis. Each ovary weighs about one drachm and a half.

Ovarian vesicles or germs.

Covered externally by peritoneum, stretched over a fibrous membrane of some firmness, the ovaries consist of a pulpy brownish-gray substance, very vascular, in which are embedded minute bodies of vesicular appearance and oval shape, varying in number from 15 to 20. These bodies, which, from the time of De Graaf at least, have been regarded as ova or embryal atoms or germs (*ova Graafiana, ovarii vesiculæ*), consist of a thin membrane containing a viscid, reddish, or yellow fluid.

The ovary is supplied with blood from arteries analogous to the spermatic of the male.

Previous to puberty the ovaries are smooth in surface and entire. After this period, both in females who have had children, and even in virgins, they are marked on the surface by minute depressions, which have been denominated *cicatrices*, and which are believed to be the consequence of minute breaches of the ovarian tunics, occasioned by the escape of the vesicles from the surface of the ovary. There is no proof that these cicatrices are the invariable result of sexual intercourse. Small before puberty, at that period they acquire considerable size, and

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retain them till the age of 45 or 48, after which they shrivel and shrink to a very small size.

Uterine tubes.

The Fallopian or uterine tubes are the excretory ducts of the ovaries. They are cylindrical tubes about four or five inches long, contained in the anterior fold of the superior margin of the broad ligament, between the round ligament and the ovary, and connected by their lower extremity with the superior angles of the womb. Their superior extremity, which is loose, is surrounded by a fringed or laciniated slip of peritoneum, in the centre of which is seen the upper or peritoneal aperture (*orificium superius*), larger than the calibre of the canal, which admits a hog's bristle, but contracts at the lower or uterine extremity (*orificium uterinum*), which is situate in the upper angle of the inner surface of the womb.

Covered by serous membrane externally, lined by thin mucous membrane with follicular glands, the Fallopian tubes consist of fibrous tissue interposed between these two. Below, however, at their junction with the womb, they seem to partake of the structure of that body.

The womb.

The womb (*uterus, matrix*) is a hollow organ with thick walls, shaped like a conoid, flattened before and behind, situate on the mesial plane in the pelvic cavity, between the bladder before and the rectum behind. Small before puberty, at that period it is about $2\frac{1}{2}$ inches long, $1\frac{1}{2}$ broad at its widest part, and weighs from 7 drachms to $1\frac{1}{2}$ ounce. It is distinguished into the *fundus*, body (*corpus*), and neck (*cervix*); the first free, directed upwards; the second also free, between the bladder and rectum; and the third connected within and below to the *vagina*. At each side of the *fundus* is a corner or angular part, which communicates with the uterine extremity of the Fallopian tube. The neck of the womb may be distinguished into the external or peritoneal, and the internal or mucous neck, which terminates in an elliptical opening, with rounded, thick, firm margins, not unlike the mouth of the tench, and named therefore *os tincæ*, as well as *os uteri*. These lips become rough and irregular in women after child-bearing, in consequence of the distension during parturition.

The cavity of the womb is small compared with the volume of the organ, in consequence of the thickness of its containing walls. It is triangular in shape, with the base at the *fundus*, and the apex at the neck. The superior angles are small recesses, in which the uterine extremity of the Fallopian tube of each side opens. The cavity is much contracted at the neck, forming a short cylindrical canal, the lower aperture of which is the *os uteri*, communicating with the *vagina*.

Structure.

Covered externally by peritoneum, the womb consists of a peculiar thick, firm, whitish substance, lined by mucous membrane. This intermediate matter, though neither red nor distinctly fibrous, has been very generally regarded as muscular. Its contractile powers during parturition it is impossible to doubt. But while it is difficult to reconcile this phenomenon with the absence of muscular tissue, it must be allowed that it is much more easy to maintain than demonstrate the unequivocal appearance of muscular fibres. On this topic the reader may consult a paper by Mr Charles Bell, in the 4th volume of the *Medico-Chirurgical Transactions;* and an elaborate account of the different ranges of muscular fibres in the uterus, by Madame Boivin, an eminent Parisian *accoucheuse*, in her *Mémorial de l'Art des Accouchemens*, Paris, 1824.

The uterine mucous membrane is thin, but reddish-gray, villous, and marked by numerous pores, the apertures of blood-vessels, most probably those which secrete the menstrual fluid. At the neck it is provided with muciparous glands, which are the seat of several of the forms of leucorrhœa.

The blood-vessels of the uterus are derived partly from the spermatic, partly from the hypogastric. The former, after passing between the folds of the broad ligaments, and giving branches to the tubes, enter the uterine substance by its lateral regions. The second, named the *uterine*, after sending branches to the vagina and neighbouring parts, ascend along the margins of the organ, and are distributed to its *fundus*.

The uterine veins correspond to the arteries in course and connections. In the walls of the organ they form large sinuses, very distinct after parturition.

The uterine lymphatics are connected with those of the pelvis and hypogastric region. The nerves, which are numerous, proceed from the lower extremity of the great sympathetic, from the renal plexus, the spermatics, the last lumbar nerves, and the sacral.

The womb is the proper ootrophic organ, to the inner surface of which the *ovum* is attached by a vascular body denominated the *placenta* or after-birth.

The vagina.

The *vagina* is a membranous vascular tube, situate on the mesial plane, behind the pubal arch and *urethra*, and before the *rectum*, and extending from the neck of the womb in the pelvic cavity to the external outlet (*vulva*), where it is continuous with the surface. Not exactly cylindrical, but flattened before and behind, its length is about four inches, its breadth one, but very distensible. It is generally distinguished into the upper vaginal recess (*vaginæ fundus*), inclosing the neck of the womb behind the *os tincæ*, the lower vagina (*vagina propria*), and the vaginal opening (*vulva*).

The *vagina* consists of mucous membrane surrounded by filamentous tissue, a vascular network, and some muscular fibres. The mucous membrane, which is red below, gray above, and not unfrequently marbled, soft and spongy, is disposed in numerous large transverse and semicircular folds (*rugæ*) on the anterior and posterior surfaces. In the recesses of these folds are numerous pores, evidently the source of the mucous viscid secretion which is so abundant on this membrane, during sexual excitation, at the period of parturition, and morbidly in gonorrhœa in the female. On the lateral regions it presents pyramidal eminences (*papillæ*).

The mucous membrane is connected by filamentous tissue to another, which in the vicinity of the uterus is compact, firm, and elastic, and below, towards the orifice, is thinner, and contains a network of numerous communicating vessels, in which the blood is occasionally accumulated in the manner of erection. The lower extremity is inclosed laterally by some muscular fibres (*constrictor vulvæ*), which are believed to have the effect of contracting the *vagina* voluntarily, and by which, when continued, as they occasionally are, to the base of the *labia magna*, women, according to Soemmering, may move these parts. The vaginal membrane is provided with lymphatics connected with those of the pelvis. The nerves, which are numerous, and some of which appear to terminate in the pyramidal eminences, are derived partly from the sacral, partly from the crural trunks.

The *vagina* terminates in the *vulva*, an opening formed within by the *clitoris* before, the *hymen* behind, and the *nymphæ* or *labia parva* on each side; externally by the *mons veneris* before, the *frenum* and navicular *fossa* behind, and the *labia magna* on each side.

The *clitoris* is a small, oblong, conical process, consisting of erectile vessels, covered by mucous membrane, attached to the lower margin of the pubal symphysis. The *hymen* is a crescentic fold of mucous membrane, surrounding the sides and posterior part of the vagina. The small lips or *nymphæ* (*labia parva*) are two crescentic bodies, consisting chiefly of erectile vessels, contained within a duplicature of semimucous membrane. With these the inner surface of the *labia* is continuous; and they consist

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chiefly of filamentous tissue, placed between semimucous membrane and skin.

The female breast

Connected with the female ootrophic organs are the breasts or *mammæ*.

The female of the human species has only two breasts; and their position on the anterior and superior part of the *thorax*, on each side of the mesial plane, is a character which, with those of the locomotive apparatus, indicates distinctly the erect biped attitude.

Of a hemispherical or conical shape, the female breast consists of a glandular organ, named the *mammary*, surrounded by adipose tissue, and covered by integuments. It is distinguished into the breast (*mamma*), the nipple (*papilla*, *mammilla*), and a coloured ring of skin (*areola*).

The gland is of a flat, rounded figure, and consists of lobes of white pulpy substance, separated from each other by filamentous tissue, and which may be resolved into granules or *acini* about the size of millet seeds, which again are composed of minute oblong vesicles disposed in a radiating manner. From the granules or *acini* proceed minute tubes named the lactiferous (*ductus lactiferi, tubuli galactophori*), which uniting into larger tubes, varying in number from 20 to 30, terminate in the centre of the mammary gland, behind the areola in conical dilated sacs (*sinus*), varying from one or two to three lines in diameter. These galactophorous ducts, which are larger than in any other gland, are formed of mucous membrane, which extends into the sinuosities, and is at the nipple identified with the skin. Several of the lactiferous tubes are said to originate from the adipose tissue of the breast; but this seems merely to indicate that they communicate with the vessels of this substance. The lactiferous tubes are indistinct before puberty, small in the virgin, and in general in the sterile, and during the intervals of pregnancy, and large only at the close of that period, and during the process of suckling.

The nipple of the female breast is a flat, conical process, the shape of which is well known, consisting externally of skin, with thin delicate corion and epidermis, internally of mucous membrane, and an intermediate network of dilatable arteries and veins mutually and freely communicating. These parts are united by filamentous tissue, which varies in quantity at different periods. But from the vessels now mentioned the nipple derives its property of occasional erection, especially under the influence of mental emotions.

The breast derives its blood from the internal mammaries, the intercostals, and the thoracics or external mammaries, the branches of which penetrate between the lobules of the gland. It has lymphatics, though not more abundantly than any other organ. The nerves are chiefly cutaneous.

The mammary gland is separated from the pectoral muscle by a thick cushion of adipose substance, on which it rests; and it derives a gentle conical elevation from the subcutaneous adipose tissue. The mammary skin is remarkable for the delicacy and softness of the corion.

CHAP. III.—THE PRODUCT OF GENERATION.

The ovum or impregnated germ, the result of the union of the sexes, consists of an embryo or new animal, inclosed in several membranes, and attached to the inner surface of the uterus by a vascular mass.

The fœtal membranes.

Of the membranes, one, the *decidua* (*epichorion*), belongs to the uterine surface; the other two, the *chorion* and *amnion*, belong to the fœtus or embryo. The *decidua* consists of two parts, an external (*decidua vera*), and an internal (*decidua reflexa*); both modifications of albuminous secretion. The chorion, the outer covering of the fœtus, is a thin transparent membrane, covered with villosities on both surfaces, but especially the external. The amnion is a thin transparent membrane, adhering feebly by its external surface to the inner of the chorion, and inclosing a watery fluid, variable in quantity, in which the fœtus, suspended by the umbilical chord, floats.

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The umbilical chord.

The umbilical chord (*funis umbilicalis*) consists of, 1*st*, one vein and two arteries, inclosed in—2*d*, a soft, semifluid, gelatinous substance, named from Wharton *gelatina Whartoniana;* 3*d*, the urachus, a ligamentous chord proceeding to the superior *fundus* of the bladder; and, 4*th*, the umbilical sheath (*vagina umbilicalis*). In the early period of uterine life, it also contains part of the intestinal canal, the *vesicula umbilicalis* either partly or wholly, and the omphalo-mesenteric vessels. Of these parts the umbilical veins and arteries, by their connection with the placenta, are the most important. The others our limits allow us merely to indicate.

The placenta.

The *placenta* is a round or orbicular, thick, cake-shaped mass, with two surfaces, a filamento-vascular, attached to the inner surface of the womb, and a smooth membranous one, to which the umbilical chord is fixed. It consists of lobular portions (*cotyledones*), separable from each other, and each of which receives a small artery derived from the uterine trunks, which are much enlarged during pregnancy. The average weight of the *placenta* is 1 pound 2 ounces.

The placenta, according to Dr Hunter (*Anatomical Description of the Human Gravid Uterus*, edit. by Dr Baillie, Lond. 1794), consists of two portions; a *fœtal* or *umbilical*, and a *maternal* or *uterine part*.

The fœtal part is composed entirely of ramifications of the umbilical arteries and umbilical vein. These, dividing with extreme minuteness, are distributed to all parts of the placenta. The branches of the umbilical arteries finally terminate in the umbilical vein, and have no other termination: all the branches of the umbilical vein arise from the umbilical arteries, and have no other commencement.

The maternal part consists of a whitish-coloured substance, which is spread over the outer surface of the placenta in the form of a membrane, and sends off innumerable irregular processes, which pervade its substance as deep as its inner surface. These are everywhere so blended and entangled with the ramifications of the umbilical system, that it is impossible to discover the nature of their union. They are interwoven in such a manner, however, as to leave innumerable small vacuities or cells between them, which communicate freely with each other through the whole mass. The maternal part is full of large and small arteries and veins, none of which are derived from the vessels of the fœtal part, but all from the arteries and veins of the uterus. All the arteries are serpentine, and much convoluted; the larger, when injected, are almost of the size of crow-quills; and, after little or no ramification, they terminate abruptly in the cells already described. This is their only termination. The veins have frequent anastomoses, pass in a very slanting direction, and generally appear flattened; some of them are as large as a goose-quill, but many of them very small; and all arise abruptly from the cells of the placenta. This is their only commencement.

Umbilical arteries.

The umbilical arteries, which are branches of the hypogastric, ascend beside the bladder and before the rectum, approach each other, pass over the *fundus* of the bladder, and reach the navel with the *urachus*. There they alter their direction, and are wound round the umbilical vein, which proceeds from the placenta by the same aperture (the navel) by which the arteries escape. These arteries, which are almost equal in diameter to the hypogastric or posterior iliac, of which they appear to be the continuation, diminish in size after birth, and appear then to be mere branches. Eventually they are obliterated and converted into solid chords, about 1½ inch from their origin.

Umbilical vein.

The umbilical vein, which is larger than both arteries taken together is the common trunk of the veins of the

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placenta, from which it proceeds through the umbilical opening or navel, in the folds of the falciform ligament, to the umbilical fossa of the liver, where it divides into two branches, one large, proceeding to the *vena portæ* and liver, another small, into the *vena cava*, known by the name of venous duct or canal (*ductus venosus*). The umbilical vein is distributed chiefly to the left lobe of the liver.

Anatomical peculiarities of the fœtus.

The structure of the fœtus differs in many respects from that of the adult; and these differences depend on the stage which the process of developement has attained. As it is impossible to trace the history of this interesting process within the limits of this sketch, we shall merely specify the principal anatomical peculiarities by which the fœtus is distinguished from the full-grown subject.

A large vascular body, denominated the thymus gland, is found to occupy the anterior *mediastinum*. The kidneys are covered by triangular filamento-vascular bodies, named *renal capsules*, larger than the glands themselves, and supplied with large blood-vessels. The liver is very large, especially its left lobe, and occupies not only the right hypochondriac and epigastric, but the left hypochondriac region. The lungs are compact and of a deep red colour, and sink in water; and the bronchial tubes are collapsed and void of air. In the heart the right and left auricle communicate freely by an oval aperture in the *septum*. The pulmonary artery, rising from the right ventricle, divides, not into two, as in the adult, but into three branches; one on each side, going to each lung, small, and conveying little blood; and one in the middle, proceeding to the aorta, about 9 lines long, named the arterial canal (*ductus vel canalis arteriosus*). The umbilical vein, proceeding to the liver, is distributed by about 15 or 20 branches to the left lobe of that organ. In the horizontal furrow it divides into two branches, one of which goes to the portal vein, the other, apparently the continuation of the trunk, opens into the *vena cava*, under the name of venous duct (*ductus vel canalis venosus*), forming with it an angle acute above, and provided with a valve. The kidneys consist of lobules as numerous as their tubular cones, which indeed these lobules are, separate from each other. The urinary bladder is not within the pelvis, but in the abdominal part of that cavity; and it terminates above in a point, to which a ligamentous process (*urachus*), connecting it to the navel, is attached. In the male, the testicles are contained in the abdomen, often immediately behind the internal aperture. Lastly, till the seventh month the pupillary aperture is closed by a peculiar membrane.

The engravings with which the foregoing article is illustrated have been sufficiently explained by literal or numeral references, in the course of description. We have only to add, that fig. 1 and 2 of Plate XXX., from Soemmerring, are intended to show the important parts at the lower surface of the brain; fig. 3, from the same, the relations of the middle band, vault, and *septum;* and the other two, from Reil, the internal arrangement of the *nucleus*. Plate XXXI., from Scarpa, shows the phrenic nerve, and the thoracic part of the pneumogastric and sympathetic, with the cardiac plexus and nerves. Plate XXXII., from Cruikshank, gives a general view of the arrangement of the lymphatics.

In the foregoing account of the anatomy of the human body, many points have been treated in a manner too short and cursory, considering their importance; and in the attempt to restrain it within due limits, the heads of several have been only indicated. It was the intention of the author to introduce all the new information in microscopical anatomy, which the researches since the year 1832 had furnished. This however, particular circumstances render impracticable. For those who wish to study the subject more minutely, besides the works occasionally mentioned, we refer to the following general systems and treatises.

1. S. Th. Soemmerring *De Corporis Humani Fabrica;* Latio donata, ab ipso auctore aucta et emendata. Tom. i. *De Ossibus*, Trajecti ad Mœnum, 1794. Tom. ii. *De Ligamentis Ossium*, 1794. Tom. iii. *De Musculis, Tendinibus, et Bursis Mucosis*, 1796. Tom. iv. *De Cerebro et Nervis*, 1798. Tom. v. *De Angiologia*, 1800. Tom. vi. *De Splanchnologia*, 1801. This work, which is excellent so far as it goes, and is particularly distinguished for clear arrangement, and distinctness, precision, and accuracy of description, is incomplete. It wants the anatomical description of the eye, the ear, and the generative organs in the two sexes. The first two defects, however, are ably supplied by the author in his *Abbildungen des Menschlichen Auges*, fol. Frankfort, 1801; and *Abbildungen des Menschlichen Hoerorganes*, fol. Frank. 1806.

Of this work a new and greatly enlarged edition, in which the deficiencies above noticed are ably supplied, was published at Leipsic between 1841 and 1844. See historical sketch.

2. *Traité d'Anatomie Descriptive;* par Xav. Bichat, Médicin du Grand Hospice d'Humanitié de Paris, Professeur d'Anatomie et de Physiologie. Tome i. à Paris, 1801; tome ii. et iii. 1802; tome iv. par M. F. R. Buisson, 1803; tome v. par Philib. Jos. Roux, Prof. d'Anatomie, 1803. The death of the author interrupted the publication of this work in the middle of the third volume, the first part of which only is by Bichat; while the sequel of that volume is compiled from the materials left at his death. This constitutes the most accurate descriptive system yet extant; and the strongest proof of its superiority is, that its descriptive portion has been very closely copied in the work of Colquet.

3. *Cours d'Anatomie Médicale, ou Elemens de l'Anatomie de l'Homme, avec des Remarques Physiologiques et Pathologiques, et les Résultats de l'Observation sur le Siège et la Nature des Maladies, d'après l'Ouverture des Corps;* par Antoine Portal, Prof. de Méd. &c. &c. Paris, 1803, tomes cinq. A complete and accurate work.

4. *Handbuch der Menschlichen Anatomie*, von J. F. Meckel, Band i. ii. and iii. Halle und Berlin, 1815. This work was translated into French in 1825, by MM. Jourdan and Breschet.

5. *Traité d'Anatomie Descriptive, redigé d'après l'ordre adopté à la Faculte de Medicine de Paris;* par Hippol. Cloquet, Docteur en Medicine, &c. This is a very good system of descriptive anatomy. In arrangement, M. Cloquet follows that of Bichat; and in description the first volume, and a great part of the second, are copied almost literally from the first, second, and part of the third of that author. It would have been quite as well had this been avowed; for it deprives Bichat of much of his most unquestionable merit, and gives an unfavourable impression of the candour of M. Cloquet. In the sequel of the second, on the vascular system, and the organs of respiration and digestion, the author has availed himself of the materials of Soemmerring.

6. *Elements of the Anatomy of the Human Body in its sound state, with occasional remarks on Physiology, Pathology, and Surgery*, by Alexander Monro, M.D., &c. 2 vols. Edinburgh, 1825.

On the subject of *General Anatomy*, on various details on the anatomical divisions and peculiarities of the Brain, on the minute structure of the Lungs, the Liver, the Kidneys, and other glands, we refer here in general, besides the works mentioned in the close of the historical sketch, to the following treatises.

7. *Elements of General and Pathological Anatomy, presenting a view of the present state of knowledge in these*

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branches of science, by David Craigie, M.D., F.R.S.E., Fellow of the Royal College of Physicians, Edinburgh, and Honorary Consulting Physician to the Royal Infirmary. Second edition, enlarged, revised, and improved. Edinburgh and London, 1848. Philadelphia, 1851. 8vo, pp. 1072.

8. *The Cyclopædia of Anatomy and Physiology.* Edited by Robert Bentley Todd, M.D., Professor of Physiology and of General and Morbid Anatomy in King's College, London. London, vol. i., 1836; vol. ii., 1839; vol. iii., 1847; vol. iv., 1852; large 8vo.

9. *Elements of Anatomy*, by Jones Quain, M.D. Fifth edition, edited by Richard Quain, F.R.S., and William Sharpey, M.D., F.R.S., Professors of Anatomy and Physiology in University College, London. In two vols. London, 1848.

10. *On the Structure of the Lungs. Researches on the Minute Structure of the Lungs in Man and the Principal Mammiferous Animals.* By M. Le Dr Rossignol. *Edinburgh Medical and Surgical Journal*, vol. lxxii., p. 88. July 1849.

11. *The Human Brain*, by Samuel Solly, F.R.S. London 1847, 8vo., pp. 628.

12. *Plates of the Brain in Explanation of the Physical Faculties of the Nervous System*, by Joseph Swan. London, 1853. 4to.

13. *Archiv für Anatomie, Physiologie, und Wissenschaftliche Medicin.* Herausgegeben von Dr Johannes Müller. Berlin, 1834–1853.

On the subject of *Chirurgical and Topographical Anatomy*, it would be difficult to refer to a more useful work than the following:—

14. *Surgical Anatomy*, illustrated by lithograph coloured engravings; by Joseph Maclise, Surgeon. London, 1849–1851. Second edition, 1853. (D. C.)

COMPARATIVE ANATOMY.

PART I.

ANATOMY OF THE ORGANS OF RELATION.

CHAP. I.—COMPARATIVE OSTEOLOGY.

Red-Blooded Animals only can be said to possess that assemblage of bones denominated skeleton; and as in these the most constant part is the vertebral column, it furnishes the general character of Vertebrated. The shells of the Mollusca and the *Crustacea* have been generally regarded as a species of internal skeleton; and in the circumstance of affording mechanical support and external protection, they indeed resemble the skeleton of the Vertebrata. But neither in mode of developement nor in chemical constitution can they be regarded as of the same nature. Hence it is only in the vertebrated classes that it is requisite to study the peculiarities of the skeleton.

Bones generally.

In general characters the bones of the Mammalia resemble those of the human subject. Like them, they are white, firm, elastic, and incompressible. They consist also of compact and reticular or cancellated tissue. In the lower animals the latter kind of structure is in general coarser and looser than in man; and in the Cetacea especially the cavities are large. In the carnivorous animals the compact structure is exceedingly dense, and gives the bone much greater weight than in other animals. In the Cetacea also the acoustic or lithoid portion of the temporal bone is of a marble hardness.

The bones of the Mammalia may, like those of man, be distinguished, according to their mechanical form, into long, flat, and short bones. Though the first class in general possess a medullary canal, this cavity is imperfect or wholly wanting in the bones of the Cetacea and Amphibia.

The cavities denominated *sinuses* are much more completely developed in several of the Mammalia than in the human skeleton. In the pig these cavities extend into the occipital bone; in the elephant they not only give the frontal bone extraordinary protuberance, but they extend into the parietal, temporal, and even the occipital bones, and contribute much to augment the volume of the head. In the ox, deer, and sheep, they communicate with the cavity of the horns.

The bones of Birds are in general whiter, firmer, and smoother than those of the Mammalia; and they consist of a firm, compact substance, which is elastic and hard in the bones of the trunk, and extremely brittle in those of the extremities. With the exception also of some of the thin, flat bones, as the sternum, they consist of thin, compact walls, inclosing large capacious cavities, which contain not marrow, but air, and which communicate by one or more minute holes with the windpipe and lungs. While these cavities, which may be regarded as the most perfect and advanced form of sinuses, diminish considerably the weight of the whole skeleton, by the density and completely cylindrical shape, they rather augment the strength. In the chick, and at birth, the bones are homogeneous and without cavities; afterwards they contain marrow; and eventually this disappears and gives place to air.

The bones of the Reptiles are not remarkable in any respect, unless in being void in general of medullary cavity. The absence of this canal was originally observed by Caldesi, and afterwards by Cuvier, in the tortoise; by Troja in the bones of the frog and toad; and by Carus in those of the turtle. In the crocodile, however, and in several of the lizard family, they are large and distinct. The bones of Reptiles also are less firm than those of Birds and Mammals.

The bones of Fishes are remarkable for great softness, flexibility, and elasticity. Those of the lamprey, shark, ray or skate, and sturgeon family, are soft, flexible, sectile, of a bluish white colour, translucent, and so elastic that a cutting instrument forced into them is speedily retruded by the resilient nature of the bony matter. From these characters, the bones of these families have been regarded as cartilaginous, and the fishes themselves have been distinguished by this character. (Pisces cartilaginei, pisces chondropterygii.) In the other fishes, the bones, though softer than those of Mammals, Birds, and Reptiles, present a greater degree of firmness and solidity, are whiter and more opaque, and are much less sectile, than those of the cartilaginous division. As in this respect, therefore, they approach the genuine bone of the Mammals, these are distinguished as fishes with osseous skeletons. (Pisces ossei.)

The bones of both classes of fishes consist of a large quantity of gelatine, with a small proportion of phosphate

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of lime. In the osseous fishes, however, the latter substance is most abundant.

The colour of the bones of fishes, though in general whitish gray, is observed to vary in certain genera. In the gar-pike (*esox belone*), for instance, they are green, and in the viviparous blenny (*blennius viviparus*), the sand launce (*ammodytes tobianus*), and two species of *labrus* (the *l. lapina* and *æruginosa*), they assume a green colour after boiling. The causes of these varieties in colour are unknown.

SECT. I.—OSTEOLOGY OF THE MAMMIFEROUS ANIMALS.

Plate XXXIV. fig. 1.

The skeleton of the MAMMALIA bears a general resemblance to that of the human subject, in the construction, shape, and disposition of its component pieces. Distinguished, like that, into head, trunk, and extremities, we recognise the importance of the trunk, and especially of the spine, in the different classes of mammiferous animals.

The spine.

The spine consists of separate vertebræ, which are conveniently distinguished, as in man, into *cervical*, *dorsal* or *costal*, *lumbar*, *sacral*, and *coccygeal* or *caudal*.

Cervical vertebræ.

The number of cervical vertebræ is the same in animals with the longest and shortest necks,—in the horse, camel, and giraffe, and in the mole and ant-eater. They are always seven. The only exception is observed in the *Ai* or three-toed sloth (*bradypus tridactyla*), which has 9 cervical vertebræ (Cuvier); and an apparent exception is presented in the dolphin and porpoise, in which the first two are consolidated into one; and in the cachalot or large-headed whale, in which the last six, sometimes the whole seven, are united or ankylosed. The last six are also united in the ant-eater and manis (Cuvier). Even in this state, however, the traces of the original separation are distinct.

In the ape the cervical vertebræ are distinguished from those of man chiefly by the spinous processes being stronger and not bifid, and in their bodies being projected more over each other before, so as to support the head more perfectly. In the ZOOPHAGA the transverse processes of the cervical vertebræ are flattened from behind backwards, and those of the *atlas* are very large, both for supporting the head and giving attachment to the strong muscles employed in defence, attacking prey, or bearing it off. For the same purpose the spinous process of the *axis* is very prominent, while the others are short and directed towards the head. In the mole and shrew the cervical vertebræ, which are void of spinous processes, are simple osseous rings, which move easily on each other, probably to facilitate the frequent motions requisite in these animals in burrowing. In the hog the cervical transverse processes are compressed and broad before, so as to appear double. In the elephant the cervical vertebræ have short single spinous processes, and the bodies projecting over each other as in the ape. In the Ruminants the length of the spinous processes diminishes as the neck is elongated. Thus they are almost wanting in the camel and giraffe, in which the arched neck is much retro-flected; and the same peculiarity is recognised in those of the horse.

From these facts it results that the length of the neck depends not on the number, but on the longitudinal extent, of the cervical vertebræ.

Dorsal vertebræ.

The dorsal, thoracic, or costal vertebræ are distinguished by forming the central fixed basis of the ribs; and their number depends on that of the latter class of bones, which is very variable. The number of costal vertebræ varies from 11, which is that of the Chinese monkey, common bat, armadillo, helmet-headed dolphin (*delphinus globiceps*), and Gangetic dolphin, to 23, which is that of the *Unau* (*Bradypus didactylus*). The most common number is 12, which is that not only of man, but of the ourang-outang, silky monkey (*simia marikina*), patas (*s. patas*), maimon (*simia maimon*), macaca (*simia cynomolgus*), baboon (*s. sphynx*), magot (*s. inuus*), mandrill (*s. maimon*), pongo (*s. pongo*), macauco (*lemur catta*), vampyre, great and horse-shoe bat, colugo (*galeopithecus*), shrew, hare and rabbit, agouti, flying squirrel, mouse and field rat, and camel and dromedary. The next most frequent number is 13, which is that of the mole, white bear, civet, the cat tribe (*felis*), the dog, wolf and fox, the *didelphis* tribe, the cavy, guinea pig and paca, the mouse tribe, excluding the two exceptions already mentioned, the long-tailed *manis*, the stag, the antelope genus, the goat, sheep, and ox, and the dolphin and porpoise. The number is 14 in the gibbon, coaïta, and weeping monkey, in the howling ape (*simia beelzebul*), the *tarsius*, the brown bear, raccoon and coati, the weazel *genus*, the porcupine, hog, and giraffe. It is 15 in the lori, hedgehog and tenrec, in the badger, pangolin, and seal. The number is 16 in the glutton, hyena, ant-eater, American lamantin, and *megatherium*. In the horse, quagga, and dugong, they are 18; in the rhinoceros 19; in the Indian elephant and tapir 20; and in the *Unau* or two-toed sloth 23, which, as already stated, is the greatest number yet known.

In the ape family the dorsal vertebræ resemble those of the human subject, but their spinous processes are long, and erect in the macaca and magot. In the bats, instead of spinous processes, which are wanting, there are minute tubercles. The want of these, however, in sundry species, leaves the column comparatively smooth behind. In the proper quadrupeds these processes are larger, straighter, and stronger, as the head is weighty or supported on a long neck, in order to give attachment to the strong yellow cervical ligament. This peculiarity is very distinct in the giraffe, camel, ox, rhinoceros, and elephant. In the dolphin they are straight, and smaller than those of the loins.

Lumbar vertebræ

The lumbar vertebræ vary in number still more, perhaps, than the cervical and dorsal; and this variety may occasionally be traced to the greater or less distinctness with which the sacral and coccygeal are distinguished. The smallest number is 2, which is that of the two-toed ant-eater, *ornithorhyncus*, and American lamantin; and the greatest 9, which is that of the lori. The most frequent number is 7, which is that of the greater part of the monkeys, the macauco, the great bat (*noctula*), the hedgehog, shrew, raccoon; the tiger, panther, puma, and cat, in the feline *genus*; the wolf and fox in the dog; the hare and rabbit; the whole murine *genus* except the hamster; and in the camel and dromedary. The next number in frequency is 6, which is that of the horse-shoe bat, the colugo (*galeopithecus*), the white and brown bear, the coati, the weasel genus, the civet, the lion, among the feline, and the dog among the canine genus, the didelphis and cavy *genera*, the hamster, the stag, antelope, goat, sheep, ox, horse, and quagga. The gibbon, coaïta, *Ai*, *Echidna* or *Ornithorhyncus hystrix* of English zoologists, six-banded armadillo, and dugong, have only 3 lumbar vertebræ; the ourang-outang, pongo, and howling ape, 4; the vampyre bat 4; the hyena, armadillo, *Unau*, and tapir, 4; the jocko, tarsier, and common bat, 5; the badger and glutton, the porcupine, beaver, pangolin, long-tailed manis, hog, giraffe, gazelle, chamois, and seal, all 5; and the agouti and flying squirrel have 8.

In the QUADRUMANA and ZOOPHAGA generally the outer side of each posterior articular process presents an apex turned backward, so that the anterior articular process of the next vertebra is locked between two eminences, which confine its movement much. Though this apex is found

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in the Rodentia, it is there shorter; and the arrangement is wanting in the other tribes. The size of the transverse processes indicates the strength of the loins,—a fact which is evinced especially in the instance of the horse, porpoise, &c.

Sacral vertebræ.

The number of sacral vertebræ is still more various, even in the species of the same genus. Thus, while in several of the ape *genus*, in the lori, in the vampyre bat, the colugo (*galeopithecus*), the coati, and two of the didelphis, there is one sacral vertebra only, most of the apes have *sacra* consisting of 2, 3, 4, 5, or 6 pieces; the majority of other animals have 3 sacral vertebræ; the hedgehog, porcupine, guinea pig, paca, hare, tiger, several of the murine genus, the ant-eater, rhinoceros, camel, dromedary, chamois, goat, sheep, and ox, have 4; the elephant has 5; the *Ai* 6; the *Unau* 7; and in the mole, white bear, and quagga, they also amount to 7. The frequency of the three sacral vertebræ in the lower animals shows that Galen, who ascribes only 3 to the human subject, must have derived this inference from the former.

These vertebræ are in the mammalia narrower than in man, and their direction forms with the spine, instead of receding backwards, a straight line; an arrangement evidently connected with the horizontal position of the former. The shape of the sacrum in the lower mammals is that of an elongated triangle; and it is further remarkable, that in those species which occasionally assume the erect attitude on the hind leg, as apes, bears, and sloths, the width of the sacrum is proportionally greater. The sacral spines, which are short in man and the ape, become longer in the Zoophaga, and form a continuous ridge in the rhinoceros, most ruminants, and especially in the mole. In the vampyre bat the sacrum forms a long compressed cone, the extremity of which is united to the ischial tuberosities, without sustaining a coccyx. The seal has two sacral bones; but the Cetacea, *e. g.* the dolphin and porpoise, are void both of sacrum and coccyx.

The coccygeal bones constitute the tail of the lower animals, and in many instances they are extremely numerous. The smallest number is 3, which is that of the magot (*simia sylvanus, pithecus, et inuus*) or Barbary ape; and the greatest yet known is that of the ant-eater, in which they amount to 40, and the long-tailed manis, in which they amount to 45. Next to these may be placed that of the coaïta 32, the baboon 31, the phalanger (*didelphis orientalis*) 30, the marmoset (*didelphis murina*) 29, the pangolin 28, the silky monkey (*simia rosalia*) and black rat 26, the weeping monkey and howling ape 25; the panther, mouse, dormouse, and elephant, 24; the lion, beaver, water-rat, Norway rat, and field-rat, 23; the flying-cat, puma, cat, dog, marmot, and rhinoceros, 22; the otter, 21; the Chinese monkey, raccoon, civet, hare, and rabbit, 20; the tiger and wolf, 19; the macauco, glutton, marten, fat dormouse, dromedary, giraffe, and quagga, 18; the tarsier, shrew, camel, and horse, 17; and other genera and species, without any determinate order, descending so low as to 9, 8, 7, 6, and 4. The quilled duckbill (*echidna, ornithorhyncus hystrix*) has only 12 caudal vertebræ, while the common one (*ornithorhyncus paradoxus*) has at least 20. The gibbon and vampyre bat are the only mammiferous animals, excepting the Cetacea, in which there are no coccygeal bones. It sometimes happens that a monkey or opossum loses a portion of its tail, when the truncated end is converted into a knotty excrescence, sometimes carious, always different from the taper point of the last coccygeal vertebra; and in this case it is difficult to determine the exact species.

In the Cetacea, in which the absence of *pelvis* affords no mark to distinguish the lower vertebræ into lumbar, sacral, and coccygeal, those below the dorsal may be regarded as *lumbo-coccygeal;* and their number is estimated by deducting that of the cervical and costal from the total number. The following table, which shows the number of the costal, the lumbo-coccygeal, and the total number of vertebræ, indicates that their number varies much in various *genera* of this family.

	d.	l.c.	t.		d.	l.c.	t.
Lamantin	16	24	46	Porpoise	13	40	60
Dugong	18	28	46	Narwal	12	35	54
Dolphin	13	47	67	Hyperoodon	9	29	45
Tursio	13	38	58	Cachalot or White Whale	14–15	39	60
D. Globiceps	11	37	56				
D. Griseus	12	42	61	Greenland Whale	15	37	59
D. Gangeticus	11	28	46	Rorquhal	14	31	52

In general, however, if we reckon the first 2, 3, or 5 vertebræ after the costal as lumbar, it may be said that the caudal vertebræ of the Cetacea vary from 22 or 25, which are the numbers respectively in the lamantin and dugong, to 34, 38, and 42, at which they may be estimated in the dolphin. We shall see that, in the dugong at least, we are guided in this estimate by the rudimental bones of the pelvis.

The coccygeal or caudal vertebræ of the Mammalia may be distinguished into two kinds; those which contain a canal in continuity with that of the vertebral column and sacrum, and those in which the pieces are solid. The first, which are next the sacrum, have articular, transverse, and spinous processes, distinct in proportion as the animals move their tails. The latter are generally prismatic in shape, diminish in size towards the extremity, and have only slight tubercles for muscular attachments. Animals with prehensile tails, as the American ape (*sapajous*), have above, at the base of the body of each vertebra, two small tubercles, between which pass the tendons of the flexor muscles. By means of this mechanism these animals can twine the tail round the branch of a tree with sufficient force to support the weight of the body.

The Mammalia with long mobile tails have often two or three small supernumerary bones placed on the lower surface of the junctions of several of the coccygeal vertebræ, from the 3d or 4th to the 7th or 8th. These sesamoid bones give attachment to muscles. In the beaver, which employs its tail as a trowel, the transverse processes are remarkable for size, while the lower spinous processes are larger than the upper ones,—an arrangement which enables it to depress the tail forcibly when it beats the ground.

The chest.

The shape of the chest in the Mammalia varies in general as the clavicles are present or wanting. In animals provided with clavicles, as the Quadrumana, bats, the squirrel, beaver, mole, ant-eater, hedgehog, and sloth, the shape of the chest approaches to the human, or is conoidal, and flattened before and behind. In those void of clavicles it is compressed laterally, from the smaller incurvation of the ribs; and the sternum makes a remarkable prominence, so that the transverse or intercostal diameter is less proportionally, and the sterno-vertebral is greater proportionally, than in man and the claviculated animals. In the long-legged animals, as the giraffe and those of the stag kind, this prominence of the sternum is sufficient to give it a keel-like appearance (*thorax carinatus*). In the carnivorous animals the chest presents its greatest longitudinal extent.

The sternum.

The ribs.

The number and shape of the ribs varies in the different tribes. In number, indeed, the ribs always correspond with that of the costal vertebræ. Thus, in the Quadrumana, Zoophaga, Rodentia, Edentata, and Ruminantia, they vary from 12 to 15 pair, with only three exceptions, the glutton, hyena, and ant-eater. In the Chinese monkey, common bat, and armadillo, they are a pair less than in

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man. While the quilled duckbill (*echidna, ornithorhyncus hystrix*) has only 15 ribs, the common duckbill (*ornithorhyncus paradoxus*) has 17; the horse and quagga have 18, the rhinoceros 19, the elephant and tapir 20, and in the *Unau* or two-toed sloth they amount to 23, which is the greatest known number. On the whole, the most prevalent number is 13. In the carnivorous animals they are narrow and dense in structure. In the herbivorous they are large, broad, and thick. In the armadillo the two first ribs are large compared with the others. In the two-toed ant-eater, which has 16 pairs, they are so broad that they are imbricated over each other like the plates of a corslet, and render the parietes of this animal's chest exceedingly solid. In the two species of duckbill (*ornithorhyncus paradoxus* and *hystrix; echidna* of Cuvier), the true ribs, in number 6, consist of two portions—a long or vertebral joined to the spine, and a short or sternal attached to the sternum. These portions are united by cartilage, so as to resemble the ribs of birds. The 9 or 10 false ribs terminate before in broad, flat, oval plates of bone, which are mutually connected by elastic ligaments.

The sternum, which is broad in the ourang and pongo, is narrow in the other species of ape, and consists of seven or eight pieces. In the vampyre and all the bat family it is narrow, but presents before or below rather a prominent azygous ridge or keel (*carina*), and an anterior extremity, broad on the sides, like a T, for receiving the clavicles. In the mole the clavicular extremity of the *sternum* is continued before the ribs, and is flat on the sides for receiving the two short clavicles. In the hog the sternum is broad behind and narrow before. In the rhinoceros, horse, and elephant, it is prolonged before and flat on the sides. In the CETACEA it is broad and thin, especially before.

Cranium.

Though the QUADRUMANA have 8 cranial bones, the sphenoid often consists of two portions, one forming the orbitar wings and the anterior clinoid processes, the other the temporal or large wings, the posterior clinoid processes, and the basilar fossa. The two parietal bones are early united into one in the CHIROPTERA and the other ZOOPHAGA, in which, however, the frontal remains biparted by a middle suture. The temporal tympanum is separated from the rest of the bone by a suture, which is seldom obliterated in the feline, canine, and *viverra* genera. The temporal tympanum is also separate in the RODENTIA, and the frontal ununited. The parietal is united in some, as the hare, the porcupine, *cabia*, marmot, rat, and squirrel; separate in the mouse, fat dormouse, and rabbit. The frontal and parietal bones of the elephant are early united with the other cranial bones, and form a vault without trace of suture. In the hog, tapir, and *hippopotamus*, the two parietal bones form one piece, while the frontal bone is biparted; and though in the rhinoceros both are biparted, the frontal is early united into one portion. The sphenoid bone of the animals of this tribe long consists of two pieces, one forming the orbitar wing; the other the temporal wings, which, it is to be further observed, are the smallest, in opposition to their proportional dimensions in man. In the Ruminants and SOLIDUNGULA the frontal remains long parted by its middle suture; but the two parietals are represented by a single bony vault. The tympanum is always distinct from the temporal bone. In the seal and walrus the parietal and the frontal consist of two pieces. The lamantin has only one bony arch, representing the two parietal and the squamous part of the temporal bones, while the temporal tympanum is detached from the rest of the bone. In the other CETACEA the parietal bones are at an early period united to the occipital and temporal bones, so that the five form one solid portion. The auditory or pyramidal bone is always detached from the temporal, and adheres to the cranium by soft parts only. The sphenoid is not only long separate, but consists of several portions.

Though, among the QUADRUMANA, the cranium of the ourang-outang approaches that of man in shape, it differs nevertheless in the connections of the constituent bones. The temporal wing of the sphenoid bone is very narrow, does not reach the parietal, and touches the frontal only by its upper extremity, so that the temporal bone is partly articulated with the frontal. The temporal suture is not imbricated, but serrated. The same mode of connection is observed in the mandrill, macaca (*s. cynocephalus*), magot, and guenon (*Cercopithecus*), or tailed monkey tribe. In the American monkey the temporal wing of the sphenoid touches neither the frontal nor the parietal bones; but the temporal bone is articulated directly with the malar by its flat portion. In the American monkeys the frontal bone does not touch the temporal wing of the sphenoid, and the parietal is articulated to the malar. In the howling ape (*simia beelzebul*) the connections are as in man.

Connections.

The connections of the cranial bones are in the ZOOPHAGA the same as in man. In the RODENTIA the sphenoid is joined to the frontal and temporal, without touching the parietal; and the orbitar and temporal *fossæ* are very small. In the armadillo, pangolin, and sloth, the connections are as in the RODENTIA; but in the ant-eater the parietal bone, continued below the cranium, is united to the sphenoid at the posterior part of the orbito-temporal *fossæ*.

In the elephant, though the cranial bones are at an early period consolidated into one, the auditory is always distinct from the temporal bone. In the hog, tapir, rhinoceros, and hippopotamus, the sphenoid is united to the parietal bone, and its temporal wings occupy a small space only of the orbitar and temporal fossæ. The orbitar wings, though larger, appear small externally. The auditory bone, though distinct, is, however, united by its base to the margin of the auditory canal of the temporal bone. The sphenoid of the ruminants is articulated, as in man, with all the cranial bones; but its orbitar wing, which is extensive, is principally concealed within the cerebral cavity, and covered by the orbital part of the frontal bone. In the CETACEA generally, all the sutures which remain after early life are squamous or imbricated.

The outline of the frontal bone in the ourang-outang is more irregular than in man, and the orbitar arches are less surbased. In the American monkeys its outline is triangular, and terminates in a point towards the vertex. In the others of this family (*Simia*), this bone is almost elliptical, and the orbitar arches are nearly straight; and in the whole family these arches form, as in man, the anterior border of the frontal bone, in consequence of the narrowness of the root of the nose. In the makis it begins to widen, and the eyes become oblique,—a circumstance which gives their frontal bone a rhomboidal shape.

The frontal bone in the ZOOPHAGA, and in all the subsequent MAMMALIA, except the CETACEA, forms an irregular prismatic or cylindrical surface with three faces—a superior, bounded before by the muzzle, behind by the cranial convexity and two lateral, descending into the orbitar and temporal *fossæ* on each side. The hedgehog, mole, shrew, ant-eater, some of the *phocæ*, the morse or walrus, and the rhinoceros, have no proper orbitar arches; and the frontal bone, though broad behind, is contracted and nearly cylindrical between the orbits. In the hippopotamus, the ruminants, and the one-hoofed animals, it enlarges, and forms a vault over each orbit. Lastly, in the CETACEA it is narrow from before backward, resembling a fillet stretched across the cranium, but descends beneath the maxillary bones to form the floor of the orbit.

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The parietal bones of the ourang-outang differ from those of man only in their temporal margin being nearly straight. Those of the ape are narrower, and become more oblique-angled as the cranium is flattened. In the Zoophaga and Edentata they are almost rectangular. The single parietal of the Rodentia is nearly quadrilateral; but it is sometimes flat, sometimes rounded, sometimes surmounted by a crest. Of the single parietal bone of the ruminants, that of the stag, most of the antelope *genus*, the sheep and the goat, is broad, and sends on each side a narrow process into the temporal *fossa* before the occipital arch; in the camel it is narrower, and bears a longitudinal crest; and in the ox and *antilope bubalus* it is placed behind the occipital crest, and resembles a fillet surrounding the back of the head transversely. In the Solidungula the single parietal is nearly quadrilateral, and placed before the occipital crest.

The occipital bone.

The occipital bone in the lower mammalia is remarkable for five characters. 1. The proper occipital surface, instead of being oblique or horizontal, and inferior or basilar, becomes vertical and posterior. 2. The plane of the occipital hole forms with that of the orbits an angle constantly diminishing, becomes parallel to the orbitar plane, and at length crosses it above the head. 3. The plane of the occipital condyles, instead of being transverse and horizontal, becomes oblique, and at length vertical. 4. The basilar or cuneiform process is not only horizontal, but forms with the occipital a right angle. And, 5. The mastoid process, which in man and the ape forms part of the temporal, belongs in the other mammalia to the occipital. In the polar bear, however, the mastoid process constitutes part of the temporal bone.

From the 1st, 2d, and 3d characters, it results that the head of quadrupeds is not balanced on the spine, but is suspended by muscles, tendons, and ligaments, especially the strong cervical, which connects the occipital spine to the spinous processes of the cervical and dorsal vertebræ. This ligament, therefore, though feeble and indistinct in man, is strong, particularly in quadrupeds with heavy head or long neck, in order to counteract the disadvantage of the long lever. It is strongest in the elephant, and is almost wholly ossified in the mole—a condition requisite for the burrowing faculty exercised by that animal.

The temporal bone.

The temporal bone is naturally distinguished in the Mammalia into two parts; a flat or proper temporal, corresponding to the squamous part of the human temporal bone, and the pyramidal, acoustic, or auditory, corresponding to the pyramidal or lithoid portion of the human subject. The first only, which is proper to the scull, claims attention here. In the ourang-outang and most of the genus *simia* it forms a trapezium with the longest side above, and the height of which varies with that of the scull. In the American apes it is smallest in this direction. In the Zoophaga the proper temporal bone is as in the ape. Being narrow in the Rodentia behind, it is a little rounded in the short-muzzled Edentata, the Ruminantia, and Pachydermata.

The ethmoid is, strictly speaking, the olfactory bone, and shall be mentioned under the organs of sense. The sphenoid, among other offices, may be regarded as the essential ophthalmic bone.

The facial bones.

The facial bones of the lower Mammalia differ from those of man; first, in the number of separate pieces; and, secondly, in the form and proportional horizontal extent.

Intermaxillary bones.

The difference in number consists in each superior maxillary bone being divided into a maxillary bone proper, and an anterior or labial portion; which being interposed between the proper maxillary, are commonly denominated the intermaxillary (*ossa intermaxillaria*). As it bears also the superior incisors, it is named by Haller the incisive bone (*os incisivum*); but since it is found not only in the ruminants, which, excepting the camel, are void of incisors, but in the Edentata and Cetacea, this denomination is less applicable than the former. It may be doubted whether these should be regarded as additional bones, as they are generally represented by zootomists; for they are in truth merely the incisive or anterior portion of the superior maxillary bones. In other respects, the difference between the human and the animal superior maxillary bone is, that in the former each bone is in one piece, in the latter it is in two. Even in the human fœtus the trace of the separation may be recognised; and we have seen it in the human scull some years after birth. Conversely, it is early obliterated in some quadrupeds. Thus, though distinct in the ourang-outang seen by Cuvier, it was not found by Tyson or Daubenton, and is wanting in one preserved in the Hunterian museum. In a young specimen of the jocko also, noticed by Cuvier, no trace of the intermaxillary suture was observed. It appears also to be wanting in the perforated bat, the horse-shoe bat, and the three-toed sloth.

Mutually united on the mesial plane, the intermaxillary bones are united to the maxillary by sutures, which pass from the outer angles of the latter, near the incisive holes, towards the palate, where they intersect. In form and size it varies in the different orders and genera. Small in many of the Zoophaga and the walrus, it is large in the Rodentia, in the hippopotamus, porpoise, and cachalot, and prominent in the wombat. In the duckbill it consists of two unciform portions, united by a broad intermediate cartilage.

Elongation of the face.

The peculiarity of the animal face consists in the horizontal elongation of the two jaw-bones. In the monkey tribe this elongation is trifling; and all that is remarked is, that the palate and maxillary bones are more elongated in proportion to their height, and that their anterior part, instead of being vertical, is more or less inclined forwards. The degree of this elongation, which differs in different *genera*, may be estimated by the acuteness of the facial angle.

Interorbital region.

The narrowness of the interorbital space is another character of the animal countenance. In the *guenon* and American ape it is a mere *septum;* but in the ourang-outang, magot, and howler, it is larger, by reason of the nasal *fossæ* ascending to this height. From these the face of the Zoophaga is distinguished by the following circumstances. 1. The breadth of the ascending maxillary processes throws the orbits to the sides; 2. these orbitar surfaces form the anterior wall instead of the floor of the orbit; 3. the malar bone is united neither to the frontal nor to the sphenoid bone, and forms only the zygomatic arch and the lower margin of the orbit; 4. the orbit, closed neither behind nor below, communicates freely with the temporal *fossa;* and, 5. the palate bones are much elongated and form a considerable space of the internal wall, to which the ethmoid bone does not contribute. In the Rodentia the interorbital space is still larger, by reason of the size of the intermaxillary bones throwing the maxillary backwards and to the sides, where they form the inner orbitar wall, in which the palate bones occupy only a small space. The anterior wall is formed by a process of the maxillary, which contributes to form the zygomatic arch, while the malar is suspended in the middle between the process and that of the temporal bone. Very similar is the face of the elephant, except that the height of the *alveoli* from the tusks, thrusting the nose upwards, and shortening its bones, alters entirely the expression of the head of this animal.

In the sloth, in which the face is short in proportion to

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the scull, the malar bone attached to the maxillary only, is not united to the zygomatic process of the temporal. In the long-muzzled EDENTATA, in which the face is conoidal, the maxillary bones extend to the orbits, and are separated by a broad lacrymal bone, while a long palate bone forms the inner wall of these *fossæ*. The zygomatic arch, which is interrupted in the ant-eater and pangolin, is completed in the Cape ant-eater and the armadillo. In the tapir and rhinoceros the maxillary bone passes beneath the orbit; and the nasal bones form a sort of vault, which supports in the first animal the trunk, and in the second the horn.

In the CETACEA the maxillary and intermaxillary bones form a sort of flattened beak, distinguished into four parallel bands, of which the maxillary, which are external, alone bear teeth in three genera, provided with the latter organs. The nasal *fossa* is a vertical opening before the cranium, surrounded before and laterally by the intermaxillary bones. The maxillary ascend in the same manner, and cover that part of the frontal bone which forms the orbitar vault, but do not themselves contribute to the formation of this cavity. The nasal bones are two minute tubercles implanted on the frontal bone above the narrow aperture. The malar is in the shape of a style, suspended by cartilages beneath the orbit; and the latter cavity is completed behind by a process of the frontal, which joins the zygomatic of the temporal bone, and below which the orbitar and temporal *fossæ* communicate.

Orbits.

The direction of the orbits, the shape of their base or facial border, and their relation to the temporal *fossa*, are important circumstances in the animal face and cranium. In the *simiæ* the angle of the orbitar axes is rather smaller; and the shape of the margin, which is quadrilateral in the jocko, becomes oval in the ourang-outang and American monkeys. The angle of the axes enlarges in the other Mammalia; and the base or anterior margin becomes nearly circular in the ZOOPHAGA, RODENTIA, EDENTATA, and PACHYDERMATA; but the arch is incomplete behind. In the *Ruminants* and SOLIDIPEDA, however, in which it is also circular, the border is complete. In the CETACEA the orbitar vault is semicircular, their axes are rectilineal, and there is no floor.

In the human scull the junction of the malar bone with the frontal and sphenoid completes the orbit externally, and prevents it from communicating with the temporal *fossa*; and the same arrangement is observed in the *simiæ*. In the CARNIVORA, RODENTIA, EDENTATA, and PACHYDERMATA, however, in which the malar bone is united neither to the frontal nor the sphenoid, the orbit is not only incomplete on the external posterior border, but communicates freely with the temporal *fossa*. In the Ruminants is observed an arrangement intermediate between that of the QUADRUMANA and that of the CARNIVORA. The malar bone, united to the frontal, completes the orbitar ring; but as it is not united to the sphenoid, it allows the orbits and temporal *fossæ* to communicate. The orbit of the mole is so superficial, that it can scarcely be said to exist.

The lower jaw.

The lower jaw of the mammiferous quadruped differs from that of man chiefly by the following circumstances. The triangular flat surface which constitutes the chin, and which is most distinct in the Caucasan race, begins to become faint in the negro, and is altogether lost in the monkey tribe. In the ourang-outang, indeed, the animal character of the lower jaw appears distinct in the vertical convexity of the anterior arch of the jaw, and the retreating of its lower margin. In the lower QUADRUMANA the anterior maxillary arch is still more retreating, and the maxillary *rami* form a more acute and elongated angle. These animal characters are still more conspicuous in the CARNIVORA, most of the PACHYDERMATA, Ruminants, SOLIDUNGULA, and RODENTIA. The ascending *ramus* also becomes short in the PACHYDERMATA and several of the CETACEA, more so in the ZOOPHAGA, and is almost extinct in several of the RODENTIA, for instance the paca, beaver, and porcupine, and the armadillo, ant-eater, and duck-bill, among the EDENTATA. In the ZOOPHAGA, however, in which the prehensile and masticatory muscles are large and powerful, the *ramus* becomes broad, and its coronoid process is extensive. The angle which the *ramus* forms with the body of the jaw, and which is almost right in the adult human subject, becomes obtuse in the lower animals, nearly at the same rate at which the *ramus* disappears; and indeed the transition of the angle into a straight line implies the disappearance of the *ramus*. This, therefore, is the character in the EDENTATA and CETACEA, in which there is neither *ramus* nor coronoid process, after these parts have been seen for the last time in the amphibious MAMMALIA.

When the mammiferous cranium is considered generally, and the relative direction and proportion of the cranial and facial part of the head examined, we recognise more distinctly the characters by which the lower orders of that class are distinguished from man. This character consists in the position of the occipital bone and hole, the position and direction of the facial bones in relation to the frontal, the elongation of the former, and large size which they present in relation to the cranial.

In the human subject, it has been already observed, the position of the occipital bone is oblique and horizontal, and the plane of the occipital hole is horizontal, while its position is anterior. In most quadrupeds, while the bone assumes a vertical position, the hole becomes posterior, and its plane vertical or oblique, in proportion as the face is elongated. The plane of the occipital hole forms with that of the horizontal a considerable angle, which Daubenton undertook to determine, by drawing one line through the plane of the aperture, and another from its posterior margin through the lower edge of the orbit. (*Mém. de l'Acad. des Sciences de Paris*, 1764, p. 568.) In the horse this angle is about 90°, while in the ourang-outang it is only 37°, and in the *lemur* 47°. In other respects, however, it furnishes an imperfect result, since in most quadrupeds which differ very much it ranges between 80° and 90°.

Camperian line and angle.

The direction of the face in relation to that of the cranium, determined according to the method of Camper, furnishes more accurate results. While in the human subject it varies, according to the races, from 70° to 80°, in the ourang-outang it is only 65°; in the American and long-tailed monkeys about 60°; in the macaca and baboon about 45°; and, lastly, in the mandrillo, the most vicious and ferocious of the monkey tribe, only 30°. In some species in which the ear is elevated and the guttural *fossa* deep, for instance in the pongo and *alouate* or howler, the small size of this angle does not indicate proportional elongation of muzzle; and to rectify this inconvenience, it is requisite to draw the basilar line of the facial angle parallel to the base of the nostrils. With this modification, however, the Camperian line admits of correct application to the human race and QUADRUMANA only, in which the frontal sinuses are small and not prominent. In quadrupeds, for instance the carnivora, several of the ruminants, and in the elephant, the frontal sinuses are so large and prominent as to affect the results given by the facial angle very materially. In other orders, again, for instance the RODENTIA and the morse, the nose occupies so much space that the cranium is inclined backwards without its walls being free before; and it is impossible to know where the facial line passes. These, therefore, must be measured by the inner surface. Lastly,

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in the CETACEA the pyramidal elevation of the cranium above an elongated but flattened face renders the facial line much more vertical than it ought to be. The following measurements show the angle subtended by a line drawn parallel to the base of the nostrils, and another passing by the anterior margin of the *alveoli*, and touching the convexity of the cranium, whether the point of contact be concealed by the face or not.

European infant	90°	Mastiff, tangent within	31
European adult	85	Hyena, without	40
European aged	75	Ditto, within	25
Negro adult	70	Leopard, within	28
Young ourang-outang	67	Hare, within	30
American monkey	65	Marmotte, within	25
Java monkey	57	Porcupine	23
Young mandrill	42	Pangolin	39
Coati	28	Babiroussa	29
Pole-cat	31	Ram	30
Pug-dog	35	Horse	23
Mastiff, tangent without	41	Dolphin	25

Method of Cuvier.

Aware of the imperfect results obtained in this method of measurement, Cuvier proposes to estimate the relative proportion of the cranial and facial part of the head, by comparing the respective areas exhibited by a longitudinal and vertical section of both. In this section the area of the cranium is to that of the face sometimes in a ratio of majority, sometimes of minority, occasionally of equality.

In the European the area of the cranial section is about four times that of the face, excluding that of the lower jaw. In the negro the cranial area remaining the same, that of the face augments about one fifth, whereas in the Calmuck it augments only one tenth. In the ourang-outang the proportion is still less. In the American ape the facial is almost half the cranial area. The ratio is that of equality in the mandrill and most of the CARNIVORA, except the varieties of short-muzzled dogs, as the pug, in which the facial is rather less than the cranial area. In the RODENTIA, PACHYDERMATA, Ruminants, and SOLIDUNGULA, the facial is larger than the cranial area. Among the RODENTIA, in the hare and marmot, it is a third larger; in the hedgehog double; in the Ruminants almost double; in the pig a little more than double; nearly triple in the hippopotamus; and almost four times in the horse. In the morse and elephant the face is rendered large by the height of the *alveoli;* and it may be regarded as augmenting the organs of the senses. The cranium of the CETACEA is very convex, and the face very flat, and the proportional area of the latter is thereby diminished. The facial area of the dolphin may be a third larger than the cranial.

The outline of the cranial section in the human subject is oval, that of the facial section forms a triangle, with the longest side contiguous to the cranium, and the smallest without, while the angle formed by the latter with the third side or palate is the facial. In the lower animals, this triangle, which may be named the *facial*, becomes so much elongated, that the cranial side, which is the longest in man, becomes the shortest of the three in the *cynocephalus* and mandrill, and continues so in the other quadrupeds.

The pelvis.

The basin (*pelvis*) of the MAMMALIA in general agrees with that of man in forming a part common to the trunk and the lower extremities. It differs, however, altogether in the direction which it takes, which is obliquely backwards, with its anterior opening or brim forwards and downwards, and in the bones being smaller and much narrower; both of which characters are connected with its not being used in the lower animals to oppose the gravitating weight of the abdominal and pelvic *viscera*. In the apes, most similar to man, the coxal bones are much elongated; and in the ZOOPHAGA, their superior or ilial part is not much broader than their pubal. In the Ruminants, the PACHYDERMATA, and SOLIDUNGULA, the ilial portions again become broad; and in the elephant and rhinoceros especially, this width, combined with the length of the ilio-pubal *rami* and the concave abdominal surface, concurs to give the *pelves* of these animals the prodigious capacity by which they are distinguished. The *pelvis* of the amphibious MAMMALIA differs from that of the ZOOPHAGA only in being narrow and elongated, and in the *pubis* being thrown behind. In the ant-eater, mole, and shrew, the pubal junction is open as in birds; and in the two latter *genera*, the bones are so narrow that the sexual and urinary organs are placed without its circumference. In the sloth *genera*, e. g. the *Ai* and *Unau*, the pelvis is wide, the cotyloid cavities turned upwards, and the ischial tuberosity is united with the sacrum, so as to convert the ischiatic notch into a hole. This sacro-ischial junction is also observed in others of the EDENTATA, as the ant-eater and armadillo, and in the *phascoloma* (*didelphis ursina*). The marsupial animals present two minute bones, one on each side, connected by movable articulation to the pubis, and which are employed to sustain the mammillary pouch (*marsupium*) or nipple-bag, in which the young are reared after exclusion from the *uterus*. These bones, which are distinguished by the name of marsupial (*ossa marsupialia*), are oblong and flattened. Lastly, in the CETACEA, in which the pelvic extremities are wanting (Plate XXXIV. fig. 2), the pelvis is also so far deficient, that instead of consisting of the sacrum and coxal bones, it is represented by a small bony appendage, suspended in the soft parts on each side of the anus, and which, meeting at angles on the mesial plane so as to form a bone like the letter V, are merely a rudiment of the ischial bones.

The shoulder of the MAMMALIA generally differs from that of man by the absence or the proportions of the collar-bone, and by the shape of the *scapula*.

The collar-bone.

The collar-bone exists in the QUADRUMANA nearly as in man; but it is wholly wanting in the three orders of UNGULATA—PACHYDERMATA, the Ruminants, and the SOLIDUNGULA—and in all the CETACEA. Between these extremes it is found in various forms in the intermediate orders of the UNGUICULATA. Among the ZOOPHAGA it exists in the CHIROPTERA, especially the bats proper, in which it is strong and large; the INSECTIVORA, as the hedgehog, shrew, and mole *genera;* and in the didelphis or opossum among the marsupial animals. In the others of this order, as the bear, raccoon, coati, weasel, otter, dog, cat, and seal, the collar-bone is represented by clavicular bones, suspended among the muscles, touching neither the sternum nor acromion; and in some species it is altogether wanting. The RODENTIA may be distinguished into two subdivisions, as they are provided with or void of collar-bones. The first comprehends the squirrel, beaver, and mouse, with the *helamys*, marmot, and aye-aye or cheiromys *genera*. The second consists of the porcupine, hare, and cavy *genera*, as the guinea-pig and paca, in which the collar-bone is rudimental only, suspended among the soft parts. It exists in most of the EDENTATA, as the sloth, armadillo, ant-eater, and the gigantic fossil animal named *megatherium;* but it is wanting in the pangolin, and was believed to be wanting in the *echidna* and duckbill till Cuvier demonstrated its existence. In the CETACEA there is no vestige of collar-bone.

From these facts it results that the clavicle exists in all animals, the fore legs of which are frequently or habitually protruded, either to seize, as apes and the RODENTIA; or to fly, as bats; or to dig and burrow, as the mole; or to rake the ground, as the hedgehog and ant-eater. In the mole particularly, the collar-bone, instead of being long, is

a broad, thick, short, quadrangular bone; and while it is connected to the acromion by a ligament, it is articulated to the humerus by a large facette. The collar-bone of the *echidna* and *ornithorhyncus* is very singular. It consists of a broad central bone, surmounted by two transverse branches spreading out on each side, so as to give the whole bone some resemblance to the letter T, but sinuated so as to make the diverging branches like the Greek *υ*. In young animals this bone consists of three portions. The two diverging branches are genuine collar-bones, and may be regarded as a bifurcated bone; while the middle is supported on the sternum, and has articulated to each side a part of the *scapula*, corresponding to the coracoid process. The collar-bone, indeed, is a powerful buttress, which prevents the arm-bone from being thrust too much forward.

The shoulder-blade.

Of the shoulder-blade or *scapula*, which is present in all red-blooded animals with thoracic extremities, and hence in all the Mammalia, the principal point is to remark the varieties which its shape presents. Though in man, most of the Quadrumana, the Chiroptera, and the elephant, the vertebral margin or base of several authors on human anatomy is the longest, it becomes the shortest in most quadrupeds, especially those which, like the Ruminants and the Solidungula, have long legs and narrow chest. In most of them, also, this margin, instead of being straight, is rounded, as in the Carnivora and Rodentia. In the Carnivora without collar-bone, the hedgehog and *didelphis*, the acromion is less prominent; there is another eminence directed backwards, almost perpendicular to the spine. The coracoid process, also, which is present in the Chiroptera, the hedgehog, and *didelphis genus*, is wanting in most of the zoophagous tribe. In the hare the acromion terminates in a long slender process, rising at right angles and bending backwards, which may be named the *recurrent*. In the Ruminants and Solidungula, not only are this and the acromion, but even the coracoid, wanting. The *scapula*, again, of the hog and rhinoceros is remarkable for the disappearance of the spine at the glenoid angle; while from its middle proceeds a prominent process towards the costal or inferior margin. In the mole the scapula is long and narrow, like a cylindrical bone, placed parallel to the spine,—an arrangement which, together with the shortness and thickness of the clavicle, already mentioned, is evidently connected with the burrowing habits of this animal. Lastly, in the *echidna* and *ornithorhyncus*, which in so many characters of organization approach the Amphibia on the one side, and the Birds on the other, the scapula is a single sinuous bone, attached by one extremity to the sternum and middle part of the clavicular bone, with the other loose; and in the middle an articular cavity, in which the head of the humerus is placed, and which evidently corresponds to the glenoid. In this instance, therefore, the clavicle and *scapula* may be regarded as united into a single bone.

The humerus.

The *humerus*, which exists in all the animals with thoracic extremities, undergoes considerable variations. In the lower animals generally it is much shorter than in man; and it is invariably shorter in proportion as the *metacarpus* is elongated. Thus, in animals with what is named a *cannon* bone, that is, one metacarpal, as in the horse and the ruminants, the *humerus* is so short that it is concealed in the soft parts as far as the cubit. In the Cetacea it may be said to attain its maximum of brevity. In the bat and sloth it is long in proportion to the rest of the body.

The *humerus* of the mole is perhaps the most extraordinary of all those of the mammiferous animals. Not only is it articulated with the *scapula* by a small head, but it is connected with a facette of the clavicle by another belonging to the great tuberosity, and between which and the head is a deep pit. The crest of the small tuberosity is so large, that it represents a square placed vertically, so that the *linea aspera* is above. The rest of the body of the bone, which is very short, is arched above, so that the cubital extremity is directed upwards. From this arrangement it results that the cubit is elevated above the shoulder while the palm is turned downwards,—a disposition necessary for the burrowing habits of the animal.

Radius and ulna.

In the *simiæ* the *radius* and *ulna* are arranged as in man, except that in the *cynocephalus*, mandrill, magot, and guenon, the coronoid process of the *ulna* is narrower, and the radial facette deeper. In the other Mammalia the *ulna* very generally disappears or becomes rudimentary only. In the bat family and the colugo (*galeopithecus*) the *ulna* is wanting or is represented by a slender style placed below the radius. These animals are therefore destitute of the power of pronation and supination. In the Zoophaga, the *radius* and *ulna*, though separate, are void of rotatory motion; and the *olecranon* is compressed, and continued farther back than in man. In the Pachydermata the *radius* is before and the *ulna* behind, and, though distinct, there is no rotation. In several of the Rodentia, for instance the marmot, porcupine, &c. the coronoid process is small, and in others, *e. g.* the cavy, hare, and mouse family, it is altogether effaced. In the Ruminants the *ulna* is united immovably to the radius; and in the Solidungula it is represented by an *olecranon* adhering to the posterior surface of that bone. In the Cetacea, though both bones are present, they are much flattened.

Carpus.

The *carpus* of the ape *genus* contains one bone more than that of man, situate between the pyramidal and large bone, and which seems to result from the trapezium being divided into two parts. Conversely, in the Zoophaga, but especially in the dog, cat, hedgehog, shrew, bear, and seal, the scaphoid and semilunar are united into one large bone. Those which have a vestige of thumb, as the hyena and glutton, have the trapezium very small. The mole has not only 9 carpal bones, as the ape, but a large sickle-shaped bone, which is attached to the radial margin of the fore paw, and which gives it the shape proper to the habits of the animal. The toes are further very short. Of the Rodentia, the hare resembles the ape; but in the beaver, marmot, squirrel, and cat, the scaphoid and semilunar make one bone; while in the porcupine the supernumerary bone is between the pisiform and metacarpal of the fifth toe. In the two-toed ant-eater there are only 6 carpal bones, 4 in the first row and two in the second; in the three-toed sloth there are only 5, 3 in the first row and 2 in the second; the pangolin has 7; the cachecame 8 and a rudimental small toe; the elephant 8, 7 wedge-shaped and one elongated, corresponding to the pisiform; and the other Pachydermata 8. In the rhinoceros, which has only 3 toes, the trapezium only is wanting; but there is a supernumerary bone on the margin of the scaphoid, and on that of the unciform, as in the porcupine. The first range consists, in the Ruminants and Solidungula, of 4 bones; in the former, excepting the camel, the second consists of 2, and the latter of 3. Those of the Cetacea, which are much flattened, are 3 in the first row and 2 in the second.

Metacarpus.

The Mammalia generally have as many metacarpal bones as toes, that is, never fewer than 3 or more than 5, with the exception of the Ruminants, in which these bones are in early life consolidated into one named the *cannon* bone. In animals which walk on the tips of the toes, or which use them as organs of prehension, the metacarpal bones are lengthened to nearly double; and hence in all these animals the *metacarpus* is erroneously named the fore leg, and therefore it has been imagined, that in several

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of our domestic animals the different parts of the lower extremity are articulated in opposite directions to those of man. Thus the fore leg of the horse, deer, sheep, and dog are in truth the *metacarpus* of these animals; and what is vulgarly named the fore knee or *cannon* bone of the horse, is actually the *carpus* or wrist-joint. It is therefore convex on the dorsal, and concave and inflected on the palmar aspect, exactly as the *carpus* of the human subject.

In the three-toed sloth, the three bones of which the metacarpus consists are mutually consolidated at the base and with the rudiment of a fourth toe. In the Cetacea, the metacarpal bones, which are much flattened, are also mutually united.

Fore toes.

In the Mammalia generally, if we include imperfect or rudimental phalanges concealed in the skin, there are never fewer than 3, nor more than 5. The Unguiculated animals generally have 5, perfect and imperfect. The character of the perfect fore toe or finger is to consist of 3 rows or phalanges, excepting the first of the radial side, which has only 2. In the Quadrumana this is separate, and opposable to the other toes, constituting a thumb, and giving this tribe of animals a prehensible organ entitled to the epithet of hand. It is, however, shorter and less perfect in other respects than the genuine thumb of the human hand. In the *coaïta* (*simia paniscus*) it is converted into a rudimental bone, concealed under the skin.

In the Zoophaga, which have no power of grasping minute objects, the thumb or first toe is parallel to the others, and, though equal in length to these in the ursine family, it is shorter in the *mustela*, *viverra*, canine and feline *genera*. In the latter, which have the power of erecting the claws, to prevent them from being blunted in walking, the shape of the middle and unguinal phalanx is remarkable. The former is triangular prismatic, with two lateral and a plantar or palmar inferior surface. The third or unguinal phalanx is shaped like a hook, consisting of two parts. One, directed forwards, sharp and pointed, receives the nail or claw, in a long groove like a sheath. The second part of the hook, which is behind, rises vertically from the lower part by which it is articulated, and is produced into two processes, to which are attached the erecting muscles of the claw, which are flexors of the phalanx.

Among the Rodentia there is a perfect but short thumb in the hare, beaver, and jerbois; a two-phalanx but concealed one in the squirrel, mouse, and rat family, porcupine, paca, agouti; and a one-phalanx concealed one in the cavy, guinea-pig, marmot, &c. In the Edentata the number of fore toes varies much; in the *Tamanoir*, and *Tamandua* or four-toed ant-eater, the thumb-toe is obliterated; in the *Ai* or three-toed sloth, both that and the fifth toe are obliterated; and in the two-toed ant-eater, and *Unau* or two-toed sloth, these, with the second toe also, are obliterated.

The elephant has 5 perfect toes, all concealed under the thick, callous hide of the foot. In hoofed animals with 4 toes, for instance the hog, tapir, and hippopotamus, the thumb-toe is in the shape of a small rudimental bone.

In the Ruminants the single metacarpal bone (Cheselden's figure of the Deer, Plate I.) is articulated with two digital phalanges, which constitute one of the distinguishing characters of this order—the cloven foot. In some genera, at the root of these two perfect toes are two small bones, often covered with horn, which represent two other toes. The last or unguinal phalanx is always trilateral in shape. In the horse and the Solidungula generally, the two lateral toes are represented only by two bony styles, named the splint bones, situate on the two sides of the metacarpal or *cannon* bone. The three phalanges of the single toe which constitutes the foot are distinguished as the *pastern bone*, which is the first phalanx; the *coronet*, which is the middle or second; and the *coffin* bone, which is the third or unguinal phalanx, which has the shape of the hoof, rounded before, convex above, and flat below. To the back of the pastern joint are connected two sesamoid bones; and to the coffin bone is attached another, named the shuttle bone. In the Cetacea, all the phalanges, which are flattened, and often cartilaginous, are united in the fin or paddle.

The fore cannon bone.

Thigh-bone.

The thigh-bone, which is single in all the classes, follows the type of that of the human frame in general figure and parts. In the Mammalia it is, however, proportionally shorter, and its length diminishes as that of the *metatarsus* augments. In the Ruminants and Solidungula, for instance, it is so short that it is concealed by muscles against the belly; and hence it is too often overlooked and confounded with the leg. In other respects the general characters are, that it is not arched; that, excepting in the bear and some of the *simia* genus, *e. g.* the ourang-outang, it is shorter than the leg-bones; that its neck is very short, and more perpendicular to the *axis* of the *diaphysis* than in man; and that the great trochanter is raised above the head, which is directed inwards. In the *simiæ* it is quite cylindrical, and void of *linea aspera*. In the tapir the middle part is found flattened; and at the external margin there is a prominent crest, terminating in an unciform process. In the rhinoceros the great trochanter and the unciform process are so elongated as to unite almost, and form a hole between them and the *diaphysis*. The unciform process is observed also in the horse, beaver, and armadillo. The thigh-bone of the seal is so short, that the half of its length consists of the two articular extremities.

Leg-bones

Though the leg-bones of the Mammalia bear a general similitude to those of man, the *tibia* alone is constant; and the *fibula*, after becoming unusually slender, and changing its position from the outside to the posterior part of the tibia, is converted into a mere appendage, and at length disappears entirely. Thus, though it is distinct, and occupies its usual position in the *simiæ*, in the Chiroptera it is extremely slender; and since the *femora* are directed backward, the *fibulæ* are turned towards each other. In several of the Edentata, for instance the phatagin, armadillo, and sloth, it is large, curved, and remote from the *tibia*. In the dog family and the Rodentia it is altogether behind the *tibia*. In the mole and murine *genus* it is consolidated to the lower third of the *tibia*, leaving an empty trilateral space above. In the rhinoceros, elephant, and hog, the *fibula* is flattened and united to the whole length of the *tibia*. In the ruminants it is represented by a small bony appendage, placed on the outer margin of the *astragalus*, below the *tibia*, and forming the external or fibular ankle. Lastly, in the horse and Solidungula, the *fibula* is reduced to a styloid rudimental process, which is firmly consolidated in the adult animal to the upper part of the *tibia*.

Between the *tarsus* of man and that of the other Mammalia the following are the principal differences.

The tarsus.

In the *simiæ* the fibular facette of the *astragalus* is nearly vertical, and the tibial is very oblique; and the *calcaneum* wants the tuberosity, except in the pongo. In the ordinary bat family the calcaneum is elongated into a styloid process, concealed in the substance of the membranous ubiform expansions; but in the roussette (*pteropus*) the tuberosity projects beneath the foot.

In the Rodentia the calcaneum is produced considerably backwards, while the scaphoid, which consists of two parts, forms a tubercle on the sole. Among the Edentata the three-toed sloth is peculiar in having a tarsus,

consisting of four bones only, the *astragalus*, *calcaneum*, and two cuneiform bones, the first of which is articulated not only with the *tibia*, *fibula*, and *calcaneum*, but with the large cuneiform bone, without any intermediate scaphoid bone. Its connection with the *tibia* is by means of a convex articular surface, which rolls on the external part of the tarsal end of the *tibia*. From this mode of articulation it results that the foot of the sloth admits neither of being elevated nor depressed, but simply of performing lateral motions of adduction and abduction, to which it owes the power of clasping the trunks of trees and climbing, but which renders progression difficult and laborious.

The hog has a scaphoid with three ordinary cuneiform bones, and a rudimental great-toe bone beneath the first. In the tapir and rhinoceros there are only two cuneiform bones. All the animals already enumerated have the same number of metatarsal bones as of toes.

In the Ruminants the cuboid and scaphoid bones are united, unless in the camel, in which they are distinct. At the outer margin of the pulley of the astragalus is a bone which represents the lower head of the *fibula*, and which is farther articulated to the upper surface of the os calcis. In this side also there are only two cuneiform bones, which are united in the giraffe. The two metatarsal bones are always united, as in the *metacarpus*, into one, which forms a posterior cannon bone. The Solidungula resemble the camel in this, that the scaphoid is distinct from the cuboid bone, and that there are two cuneiform bones, while the peroneal rudiment and the corresponding articular surface of the calcaneum are wanting. The metacarpal are also consolidated into a single piece, named the hinder *cannon bone*, each side of which is provided with a minute bony style.

Third cannon bone.

Hind toes.

The toes of the Quadrumana and the Marsupialia are longer than those of man; but the great toe is shorter than the others, and its metatarsal bone is susceptible of separation and opposition, as the thumb or thumb-toe of the hand. Hence Cuvier, in his first classification, distinguished the latter by the name of *Pedimana*. The *Aie-aie* among the Rodentia appears to possess the same faculty. Among the Zoophaga the great toe remains always conjoined with and parallel to the others; and in the canine and feline genera it is obliterated. Among the Rodentia, that of the beaver is nearly equal to the other toes; those of the marmot, porcupine, and the murine genus, are shorter; in the paca it is almost obliterated; it is reduced to a single bone in the Cape gerboa; and the leporine genus have no trace of it. In the cavy, agouti, and guinea-pig, the great and small toes are each reduced to one bone. In the gerboa (*mus jaculus*) and alactaga (*mus sagitta*) the three middle metatarsal bones are united into a single one similar to the cannon bone of the Ruminants and Solidungula; and while the two lateral toes are distinct, though short, in the former animal, they are obliterated altogether in the latter.

Among the Edentata, the ant-eater, *orycteropus*, pangolin, and armadillo, have five toes, of which the great is the shortest in all. In the sloth the great and small toe are reduced to one small bone. The other metatarsal bones are united at their base. The toes have only two phalanges, of which the unguinal are the largest.

In the subsequent families the metatarsal bones deserve particular attention. In the elephant and Pachydermata, their tarsal extremity has a flat surface, and the phalangeal consists of a convex tubercle, which presents below a prominent line in the middle of the bone. In the Solidungula this line is above and below both. In the Ruminants, in which the cannon bone consists of the two metatarsal bones, the line of union is represented by a deep line like the tract of a saw. The elephant has 5 perfect toes; the hog 4; the tapir and rhinoceros 3; the Ruminants have two perfect toes on one metatarsal bone, and two small ones attached behind its base. The Solidungula have one perfect toe, and two imperfect, which are reduced to a single styloid bone. In these animals the body is supported in walking by the last or unguinal phalanx alone; and hence the term *foot* is not of the same import as in the human subject and animals similarly constructed. While indeed man supports his person in progression on the *os calcis* and the posterior or metatarsal phalanges, in the other mammiferous animals the former bone touches not the ground, but is always elevated above it a considerable height. All the zoophagous or unguiculated animals, excepting the plantigrade, support themselves chiefly on the unguinal and middle phalanges both of the fore and hind foot; and neither the posterior *phalanges* nor the *calcaneum* touch the ground, as is easily demonstrated on observing the gait of the hedgehog, dog, fox, cat, or similar individuals of the same family. The animals distinguished by the name of Plantigrade are believed to support themselves on the entire foot. But though the foot is certainly spread on the ground more freely than in those already mentioned, by the bear, glutton, badger, and others, it appears that not the heel, but the *metatarsus*, is allowed to touch the ground in progression. In the Ruminants and Solidungula, as already mentioned, the only part of the foot which is applied to the ground is the unguinal phalanx; and it is well known that the horse supports himself on the plantar surface of the coffin bone only.

Lastly, in the Amphibious Mammals, while the extreme brevity of the *humerus* and *femur* unfit them for progression on land without extreme awkwardness and difficulty, the expanded shape and oblique position of the metacarpal bones and phalanges, the length of the *tibia* and *fibula*, and the greater length of the first and last than the middle metatarsal phalanges, all concur to give these animals great facility in swimming. (Cuvier, *Ossemens Fossiles*, tome v. partie i. septieme partie.) In the Cetacea, again, while the total want of pelvic extremities renders motion on land quite impracticable, the fin-like disposition of the metacarpus and metacarpal phalanges, with the great strength of the lumbar, and the length of the coccygeal vertebræ, peculiarly qualify them for locomotion in the waters.

SECT. II.—OSTEOLOGY OF BIRDS.

Plate XXXIV. fig. 3.

The number of vertebræ of which the different regions of the spine consist, is not less variable in Birds than in the Mammalia. Some idea of these variations may be formed from the number exhibited in the following table by Cuvier.

Spine.

Species.	Vertebræ of Neck.	Vertebræ of Back.	Sacral Vertebræ.	Coccygeal Vertebræ.
Vultur. Vulture	13	7	11	7
Falco fulvus. Eagle	13	8	17	8
—— *haliaëtus.* Bald buzzard	14	8	11	7
—— *buteo.* Buzzard	11	7	10	8
—— *nisus.* Sparrow hawk	11	8	11	8
—— *milvus.* Kite	12	8	11	8
Strix bubo. Eagle owl	13	7	12	8
Strix ulula. Brown owl	11	8	11	8
Muscicapa grisola. Fly-catcher	10	8	10	8
Turdus merula. Blackbird	11	8	10	7
Tanagra tatao. Tanagra	10	8	9	8
Corvus corone. Crow	13	8	13	7
—— *pica.* Magpie	13	8	13	8
—— *glandarius.* Jay	12	7	11	8
Sturnus vulgaris. Starling	10	8	10	9
Loxia coccothraustes. Grosbeak	10	7	12	7
—— *pyrrhula.* Bullfinch	10	6	11	6

Species.	Vertebræ of Neck.	Vertebræ of Back.	Sacral Vertebræ.	Coccygeal Vertebræ.
Fringilla domestica. Sparrow...	9	9	10	0
——— *carduelis.* Goldfinch...	11	8	11	8
Parus major. Titmouse.........	11	8	11	7
Alauda arvensis. Lark..........	11	9	10	7
Motacilla rubecula. Red-breast	10	8	10	8
Hirundo urbica. Swallow.......	11	8	11	9
Caprimulgus Europæus. Goat-sucker.........................	11	8	11	8
Trochilus pella. Colibri..........	12	9	9	8
Upupa epops. Hoopoe...........	12	7	10	7
Alcedo ispida. King's fisher...	12	7	8	7
Picus viridis. Woodpecker.....	12	8	10	9
Ramphastos. Toucan............	12	8	12	7
Psittacus erithacus. Parrot......	12	9	11	8+
Columba œnas. Stockdove......	13	7	13	7
Pavo cristatus. Peacock.........	14	7	12	8
Phasianus colchicus. Pheasant	13	7	15	5
Meleagris gallopavo. Turkey...	15	7	10	5
Crax nigra. Curassow bird. Hocco.........................	15	8	10	7
Struthio Camelus. Ostrich......	18	8	20	9
——— *Casuarius.* Cassowary...	15	11	19	7
Phœnicopterus. Flamingo.......	18	7	12	7
Ardea cinerea. Heron............	18	7	10	7
—— *alba.* Stork.................	19	7	11	8
—— *grus.* Crane.................	19	9	12	7
Platalea Aïaïa. Spoonbill........	17	7	14	8
Recurvirostra. Avoset..........	14	9	10	8
Charadrius pluvialis. Plover...	15	8	10	7
Tringa vanellus. Lapwing......	14	8	10	7
Scolopax rusticola. Woodcock...	18	7	13	8
——— *arquata.* Curlew........	13	8	10	8
Hæmatopus. Oyster-catcher...	12	9	15	0
Rallus crex. Rail................	13	8	13	8
Fulica atra. Coot................	15	9	7	8
Parra. Jacana.....................	14	8	12	7
Pelicanus onocrotalus. Pelican...	16	7	14	7
——— *carbo.* Cormorant...	16	9	14	8
Sterna hirundo. Sea swallow...	14	8	10	8
Larus. Gull.......................	12	8	11	8
Procellaria. Petrel...............	14	8		8
Anas cygnus. Swan.............	23	11	14	8
—— *anser.* Goose................	15	10	14	7
—— *bernicla.* Bernacle.........	18	10	14	9
—— *boschas.* Duck..............	14	8	15	8
—— *tadorna.* Sheldrake.......	16	11	11	9
—— *nigra.* Black diver.........	15	9	14	7
Mergus merganser. Merganser	15	8	13	7
Colymbus cristatus. Grebe......	14	10	13	7

In this table the most remarkable circumstance is the great number of cervical vertebræ, which are much more numerous than in the Mammalia. They vary from 9, the number in the sparrow, to 23, which is that of the cervical vertebræ of the swan. The most common number is 11, which is that of 10 *genera*. The next most frequent is 12, 13, and 14, which are equally the numbers of 9 *genera*. The next is 15, which is that of 8; 10 occurs in 6, 18 in 4, and 16 in 3. In the stork and crane they are 19.

The next remarkable circumstance is, that the dorsal or costal vertebræ are greatly fewer than in the Mammalia, never exceeding the number of 11, and being more frequently about 7 or 8. Thus, while they are 11 in the cassowary, swan, and sheldrake, 10 in the goose, bernacle, and grebe, and 9 in the sparrow, lark, humming-bird, parrot, crane, avoset, oyster-catcher, cormorant, and black-diver, they are 7 or 8 in all the other *genera*, and only 6 in the bullfinch.

There are no lumbar vertebræ strictly so named, for those which extend from the chest to the tail are consolidated into one piece with the iliac bones. The tail, which is short, consists of from 7 to 9 vertebræ.

The part most variable in proportional length is the neck. It is so much longer as the feet are elevated, except in some of the swimmers, in which it is greatly longer, because they require to seek their food below the surface of the waters on which they float.

The bodies of the cervical vertebræ are articulated not by plane facettes, which would admit obscure motion only, but by portions of cylinders, which allow extensive motion. The 3d, 4th, or 5th superior vertebræ allow of anterior inflection only, and the others of posterior inflection. This gives the necks of birds an alternate serpentine inflection; and it is by rendering the two arches, of which this curvature consists, straight or convex, that the animal elongates or shortens his neck. The articular processes of the superior vertebræ are directed upwards and downwards; those of the lower are turned anteriorly and posteriorly.

Instead of transverse processes, the cervical vertebræ of birds are provided with a tubercle above, and the anterior extremity of which terminates in a narrow style, descending parallel to the body of the vertebra.

Only the most superior and inferior vertebræ have distinct spinous processes, and these have anterior as well as posterior ones. The middle ones have before two crests, which form a half-canal, and behind a tubercle, often bifid, or, when they are elongated, two rough lines. The atlas, which is articulated with the occipital bone by a single facette, has the shape of a minute ring.

Back.

As the neck of birds is movable, the back is fixed. The spinous processes of these vertebræ are in mutual contact, and they are connected by strong ligaments. Most of these processes are generally consolidated into a single continuous crest, extending along the whole back. The extremities of the transverse processes terminate in two *apices*, one directed forwards, the other backwards; and occasionally they are consolidated into a continuous mass like the spinous. That this arrangement is requisite for the trunk to remain fixed during the violent motions which take place in flying, is rendered probable by the fact, that in birds which do not fly, as the ostrich and cassowary, the spinal column retains its mobility.

The last dorsal vertebræ are often placed on the crest of the iliac bones, and they are then united, as the lumbar, on the large piece of the iliac bones, from which it results that the number of vertebræ can often be estimated in no other mode than by that of the holes of the nerves which issue from the chord.

Caudal vertebræ.

The caudal vertebræ are most numerous in the species which move the tail with most energy; for instance, the magpie and swallow. They have spinous processes below as well as above, and very long transverse processes. The last of all, to which the pinions are attached, is longest, and has the shape of a ploughshare or a compressed quoit. In the cassowary, which has no visible tail, the last bone is conical; in the peacock, on the contrary it has the shape of an oval plate, situate horizontally.

Cranium.

It was early observed by the original zoologist and traveller Pierre Belon, that the *crania* of birds were void of sutures; and that in a few only were these lines of distinction into separate bones recognised. The explanation of this peculiarity is found in the history of the ossification of the head in young birds, which shows that the cranium consists at that period of separate bones, corresponding in number and situation to those of quadrupeds. Thus, there are two frontal bones, which are continued forwards to form the vault of the orbits; two small parietal bones behind the frontal; a temporal bone on each side of the scull; a sphenoid united to the occipital, even in subjects in which the other sutures are distinct; or a spheno-occipital bone, which is early united with the temporal.

These sutures, however, are distinctly seen only in

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young birds and those recently hatched; for the bones are very early united, and in the adult bird the cranial sutures are invariably obliterated. Thus, in the domestic fowl and turkey the scull is one piece; and the only trace of suture that remains is a linear depression in the middle of the frontal bone, indicating the original formation in two halves. In the recently hatched bird, also, the sphenoid is separated from the occipital bone by a transverse suture, extending from the one ear to the other. The occipital bone is at the same time a ring, consisting of four parts; a superior, two lateral, and an inferior which is small. The sphenoid, which forms the greater part of the base of the cranium, is nearly trilateral, with a small anterior process, to which the palatine arches are articulated. It has no pterygoid processes, and does not touch the posterior aperture of the nostrils. The temporal bone, though void of zygomatic process, has a pointed style, which contributes to form the posterior margin of the orbit. The frontal bone, after covering part of the cranium, is continued forwards in a broad, thin plate, which forms the vault of the orbits, while these cavities are separated by a thin vertical bony plate which descends at right angles from the frontal bone, and is connected behind with the sphenoid. The long eminences observed on the heads of the cassowary, curlew, pintado, and some species of hocco, are produced from this supra-orbital part of the frontal bone; and their interior, which consists of loose *diploe*, communicates with that of the same bone.

Facial bones.

The face in birds is rarely so firmly consolidated as the cranium. It is composed of two lacrymal bones, forming the anterior margins of the orbits, and united on the mesial plane; two nasal bones anterior to the lacrymal; two bones corresponding to the superior maxillary, and forming the external lateral parts of the upper half of the bill; two inter-maxillary bones; two anterior palate bones, corresponding to those of the MAMMALIA; two posterior palate bones corresponding to the pterygoid processes of the sphenoid; and the lower jaw a paraboloid bone, consisting of two *rami* united before, where they are covered by the horn of the lower half of the bill. Besides these, there is in the whole class an irregular-shaped bone, common to the cranium and lower jaw, and connecting these two together. This bone, which has been rather improperly named the square, quadrangular, or quadrilateral bone (*os quadratum*), consists of a body with curvilinear hollow margins, terminating in two elevated and rather pointed processes, one of which is connected with the cavity named *tympanum*, while the other, projecting into the orbit, affords attachment to several muscles. The anomalous character of this bone has perplexed several of the most distinguished zootomists; and while Geoffroy gives it the name of *os Tympano-styloideum*, Spix considers it analogous to the annular process of the temporal bone, which in the human fœtus is separate; and Carus regards it as representing the *incus*, to which it bears a remote resemblance in shape and in one of its connections.

The quadrilateral bone.

Maxillary bones.

Both *maxillæ* are void of teeth; but the hard, horny matter of the bill covering the margins and extremities of each jaw, and constituting the mandibles (*mandibula*), is manifestly constructed to perform for BIRDS what teeth do for the MAMMALIA. But the most remarkable peculiarity of the facial bones of this class is, that the upper jaw admits of more or less motion. In the majority of instances this is effected by the jaw being united to the cranium by means of thin, flexible, elastic, bony plates; but in the parrot family the upper jaw is entirely distinct, and is connected by a proper articulation.

The base of the palatine surface of the upper jaw is divided into 4 branches, which diverge backwards. The two external ones, which correspond to the zygomatic arches of the MAMMALIA, and which are very slender, are articulated to the quadrangular bone which moves on the temporal before the ear. The two intermediate ones, which have been already stated to correspond to the pterygoid processes, and which are parallel, are placed beneath the septum of the orbits, and are articulated by their posterior extremities with a small bone, variable in shape, but named *omoid* by Herissant, which is also articulated with the quadrilateral. From this arrangement results a singular species of broken lever, not dissimilar to the parallel joint of the piston and lever of the steam-engine, and the effect of which is, that whenever the lower jaw is depressed by its proper muscles, it necessarily causes the quadrilateral bone to perform a slight rotatory motion, in consequence of which, by means of the omoid bone, the upper jaw is at the same time elevated on the elastic plates; and as soon as the lower jaw is raised, the elasticity of these plates forces down the superior one.

The upper jaw is immovable in a few instances only, and of these the *calao* or rhinoceros bird is one.

Sternum or breast-bone.

The breast bone (*sternum*) is a trilateral, boat-shaped bone, concave internally, convex with a middle longitudinal crest externally, with the base of the triangle above, and the apex, which is also incurvated backwards, below. The middle longitudinal crest, which is occasionally named the keel (*carina*), is shaped something like a spherical triangle, with the broadest side above, the base before, and the apex behind; and its prominence forms large spaces on each side for the attachment of the pectoral and other muscles used in flight. In the male wild swan (*anas cygnus*), in some species of curlew, in the crane, and in the guinea-fowl, this crest forms a cavity for the reception of the windpipe. In the ostrich and cassowary, which do not fly, the sternum is void of crest, and is merely arched strongly.

The ribs.

The ribs, which rarely exceed 10 pairs, may be distinguished into sterno-vertebral and vertebral. Though the latter are generally before, they are sometimes also behind. The vertebral end terminates in two diverging processes, one of which is articulated with the vertebral body, the other with the transverse process. The sternal extremity consists of a bony process, which performs the part of the sterno-costal cartilages of the MAMMALIA by uniting the rib to the sternum. The ribs of birds, however, are further distinguished by presenting near their middle a flat long process, projecting from the rib backwards at an acute angle, and resting on the rib immediately below, so that each rib is supported not only on the vertebræ and sternum, or the vertebræ alone, but on the next rib below. These processes are obliterated in the lower ribs.

Basin or pelvis.

The coxal bones constitute one piece with the sacrum and lumbar vertebræ. The ischial portion is united with the sacrum, and the ischiatic notch is converted into a hole. The part which corresponds to the *os pubis* of the MAMMALIA is not consolidated before so as to form a symphysis, but proceeding directly backwards, terminates in a styloid process, variable in length and slenderness. The only exception to this mode of structure occurs in the ostrich, in which the pubal bones are united below. The infra-pubal or oval hole is present in the whole class notwithstanding. It is worthy of remark, however, that in young birds this and the ischial aperture are still notches, in consequence of the deficient ossification of the parts.

The direction of the *pelvis* in birds is nearly that of the spine, that is, obliquely backwards, and deviating but little from the horizontal line.

Collar-bone.

The wings or thoracic extremities are connected to the trunk by three bones, the collar-bone or clavicle, the *scapula*, and the bifurcated bone. The collar-bones, which

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are straight, strong, and cylindrical, are articulated by a large head with the anterior and lateral part of the sternum, in which its motion is rather limited. It forms before and laterally two short processes, one anterior-inferior and internal, articulated with the bifurcated bone; the other posterior-superior and external, uniting with the scapula, and forming a cavity, in which the head of the *humerus* is lodged.

Shoulder-blade. The *scapula* is a long bone, flattened, but narrow, and slightly incurvated, with the convex side turned towards the spine, to which it is nearly parallel in position. The head or anterior extremity is thick and extensive, oblique from before backwards, and is articulated behind with the clavicle, before with the *humerus*. The free extremity is thin, flattened, and sharp. The whole bone is not dissimilar in shape to a scimitar.

Bifurcated bone, or *Furcula*. Besides these, which BIRDS possess in common with the MAMMALIA, we find an azygous bone, situate on the mesial plane, denominated in ordinary language the *Merry thought*, and, from its shape, the fork-like or bifurcated bone. It consists of two long, rounded, converging branches, united at an acute angle, and forming a broad process, flat in the vertical direction, and by which it is articulated to the anterior extremity of the crest or carinated part of the breast-bone. To the posterior or free extremities of the divergent branches are articulated the humeral ends of the collar-bones, which are thus enabled to sustain the violent motions of the humerus during flight. The branches of the bifurcated bone are separate in the ostrich, and each is united with the clavicle and *scapula* of the same side, so that the three bones form only one, much flattened, and with a hole towards the sternal extremity. In the cassowary the bifurcated bone is reduced to a mere rudimental process at the inner margin of the head of the clavicle. From these facts it results, that the bifurcated bone is particularly useful in the energetic and continued efforts of the wings in flight, and not only serves to keep the clavicles apart, but, by lengthening the distance between the collar-bones and sternum, enables the animal to use a longer lever. It is freest, strongest, and most elastic in the birds which fly best. In birds which do not fly, and which use the wings merely to sustain the equilibrium, as the ostrich and cassowary, it is reduced to almost nothing, or it is in such a rudimental and imperfect form, that it cannot keep the collar-bones apart.

Thoracic extremities. The bones of the thoracic extremities, or those of the wings, correspond in general to those of the MAMMALIA. They consist of a single cylindrical humerus, articulated with the *scapula* and collar-bone above, two bones of the fore wing corresponding to the *ulna* and *radius*, two bones of the *carpus*, two of the *metacarpus*, consolidated by their extremities, one styloid bone as a thumb, a long finger consisting of two *phalanges*, and a short one consisting of one. The thumb supports the bastard pinions, the large finger and *metacarpus* the primaries, while the small one, which is covered by the skin, is destitute. In several of the web-footed divers, for instance the duck and penguin (*alca impennis* and *spheniscus*), these bones are flattened like thin plates.

Pelvic extremities. In the pelvic extremities the thigh-bone is provided with one trochanter only, is shorter than that of the leg, and is almost invariably straight; and is arched only in the cormorant, duck, and dobchick. In the ostrich its diameter is about four times that of the *humerus*. The *tibia* differs from that of the MAMMALIA chiefly at its lower extremity. While the *fibula* adheres to it like a slender appendage as far as the middle, the tarsal extremity terminates in two trochlear condyles, with an intermediate pulley-like groove. The *tarsus* and *metatarsus* are represented by a single bone of considerable length, and the head or tibial end of which consists of a middle prominence and two lateral depressions, and which, therefore, moves in cardinal opposition, but does not admit of extension beyond the straight line. Though variable in proportion to the length in different orders, this bone is very long in the order GRALLÆ (GRALLATORES). It terminates below in 3 pulley-shaped processes, to which are attached the bones of the 3 anterior toes, with an internal margin for that of the great toe. In the ostrich there are 2 processes only, corresponding to the two toes. In the penguin tribe, however, the *tarsus* and *metatarsus* consist of 3 bones, separate from each other in the middle, but united at the tibial and digital extremities. To the tarso-metatarsal bone of the cock, and others of the Gallinaceous tribe, is attached the spur, a conical pointed excrescence of hard horny matter.

SECT. III.—OSTEOLOGY OF THE REPTILES.

The number of vertebræ, and all the other attributes of the spinal column, vary more in this class than in all the others.

Vertebræ. In the CHELONIAD or Tortoise family there are 7 cervical, 8 dorsal, connected with the shell in an immovable piece, so as to have neither processes nor articular facettes; from 3 to 5 lumbar and sacral, consolidated in like manner; and about 20 caudal or coccygeal. (Plate XXXIV. fig. 5.)

In the SAURIAL or Lizard tribe, the number 7 predominates in the cervical, being that of the crocodile and most lizards. In several, however, there are 8, as in two of the monitor genus, the American safeguard, the lizard of Fontainebleau, the dragon, the iguana, the anolis, and the gecko and scinc; and in a few, as the Nilotic monitor, and an undetermined species of monitor, they amount to 9. In the chameleon there are only 5 cervical vertebræ. Here, however, a singular peculiarity is observed. Instead of the cervical vertebræ being, as in the MAMMALIA, distinguished by being unconnected with ribs, to those, from the third to the seventh inclusive, short ribs, unconnected with the sternum, are attached. The *atlas* and *axis*, therefore, alone are proper *cervical* vertebræ; but the general analogy is observed in the cervical ribs being exceedingly short and almost rudimental. The dorsal vary from 11, which is that of the crocodile and iguana, to 29 and 30, which are the numbers in the New Holland scinc and Nilotic monitor. In the American safeguard, *cordylus*, stellio, crested basilisk, dragon, guana, and great anolis, they are 16; in the chameleon, black safeguard, and ameiva, 17; in the tupinambis, spotted gecko, and golden scinc, 18; in the green lizard and spotted guana (*polychrus*) 19; in the Fontainebleau and gray lizard 20; 21 in the Levant scinc and undetermined monitor; and 22 in the Java and New Holland monitor.

The BATRACHOID or Ranine reptiles are void of ribs, and it is impossible therefore to distinguish the first three orders of vertebræ from each other. In general, however, there are from the nape to the *pelvis* 8 vertebræ, all provided with long transverse processes, and which are longest in the last. The *sacrum* is represented by a long flattened but pointed bone, without *coccyx*. In the Surinam toad (*rana pipa*) the last vertebra is consolidated with this bone; and the transverse processes of the second and third vertebræ are so much larger than the others, that they resemble rudimental ribs. In the Salamander family there are from the head to the sacrum 14 vertebræ, all alike in shape except the first, which receives the occipital bone, and the last, which is articulated with the sacrum. These two are distinguished by wanting rudimental ribs, which are small elongated bones, movable, and articulated with the trans-

verse processes, which are directed backwards. The articular processes are large and imbricated, the posterior resting on the anterior, so as to resist the motion of the spine backwards. The sacrum consists of one vertebra only, but the coccyx or tail is composed of 27.

In the SERPENTINE tribe the vertebræ may be said to attain the most extensive numerical developement. With the exception of the head and rudimental ribs, they constitute the whole skeleton. (Fig. 3.) From the head to the tail their shape is the same, and may be distinguished into body, articular and transverse spinous processes. In some species, for instance the *boa*, the spinous processes of the back are so much separated as to allow mutual motion to a considerable extent. In others, conversely, for instance the rattlesnake, these processes are so long and broad as to touch each other, while the oblique processes, which form their bases, are imbricated over each other. In consequence of this arrangement the motion of the spine is limited behind, but more extensive on the ventral surface. The vertebral bodies, which move easily on each other, are provided with a sharp spine directed towards the tail, which somewhat limits motion in this direction.

The first vertebra differs from those of the rest of the body in supporting short or rudimental ribs; there are therefore no cervical vertebræ and no proper neck in the serpent family. The caudal vertebræ are distinguished by not supporting ribs, and by their spines both dorsal and ventral being double, and forming two rows of tubercles. The articulation of the bodies of these vertebræ is peculiar. On the anterior part of the body is a round hemispherical tubercle, while the posterior presents a corresponding cavity, so that each vertebra forms a cup and ball joint with the following one.

The number of costal vertebræ varies from 32, which is that of the blind worm (*Anguis fragilis*), to 204 in the ringed snake (*Coluber natrix*), 244 in the snake, and 252 in the *Boa constrictor*, and which is perhaps the greatest known number. Of intermediate numbers, the *Amphisbæna* has 54, the viper (*Coluber berus*) has 139, the rattlesnake 175, and the cobra di capello 192. The caudal vertebræ vary in number from 7, which is that of the *Amphisbæna*, to 112, which is that of the *Coluber natrix*. Of intermediate numbers, the blind worm has 17, the rattlesnake 26, the boa 52, the viper 55, and the cobra 63; from which it appears that the number of the caudal is not in proportion to that of the costal vertebræ.

Cranium. Of the heads of the CHELONIADS, the most remarkable characters are, that the facial line is horizontal, and quite continuous with the cranial line; that the orbits, though complete without, are continuous behind with the temporal fossæ; that the parietal and occipital bones are compressed laterally, while the latter terminates above in a sharp spine, projecting behind. The occipito-parietal and occipito-temporal sutures are distinct. The cranial cavity is small compared with the volume of the scull.

These characters are not less remarkable in the SAURIAL or LACERTINE Reptiles. The cranium of a crocodile measuring from 13 to 14 feet is scarcely capacious enough to admit the thumb; and Cuvier estimates the area of the cranial section, which is oblong, at about $\frac{1}{20}$ of that of the whole head. In these animals, indeed, the bones of the superior and inferior jaws are so much prolonged, and occupy so large a proportion of the head, that small space is left for the proper cranial cavity, which indeed is an immediate continuation of the vertebral. In these animals, also, the anatomist can trace, much more distinctly than in the more perfect, the resemblance between the cranial bones and the vertebral. In the CHELONIADS, and SAURIAL especially, the occipital bone is very distinctly a cephalic vertebra.

Still more manifest is this arrangement in the RANINE or BATRACHOID and SERPENTINE or OPHIDIAL Reptiles. In the former, as exemplified in the frog, the occipital bone, which forms the posterior cranial vertebra, consists of four pieces, and has two articular processes. The middle cranial vertebra is represented by the parietal bones above and the posterior part of the sphenoid below, while between it and the occipital or posterior is contained the temporal as the organ of hearing. The third or anterior cranial vertebra is represented by the anterior part of the sphenoid bone below and the two narrow frontal bones above. The face, which may be regarded as the organ of the senses, is elongated anterior to the head, somewhat after the manner of the CHELONIAD family; while an approximation to the BIRDS is indicated in the articulation of the lower jaw, which is connected to the head by the intervention of a quadrilateral bone.

In the Serpentine family, the cranium of which is very similar in other respects, the most remarkable deviation is in the want of ethmoid bone. The lower jaw is connected to the cranium by an intermediate bone, corresponding to the quadrilateral, but of an oblong shape, and something like a collar-bone.

The chest of the REPTILE class varies much in the mode of formation. While true ribs are recognised in the SAURIAL family only, the BATRACHOID reptiles have a sternum without ribs, the SERPENTINE ribs without sternum, and the CHELONIAD ribs united into the dorsal shell, and a sternum expanded into the abdominal one. Chest.

In the SAURIAL family the ribs correspond in number to that of the costal vertebræ already mentioned, that is, 12 in the crocodile and iguana, two of which are not connected to the sternum, 17 in the chameleon, 18 in the tupinambis, and 27 in the monitor. The SAURIAL reptiles, however, are peculiar in having from 1 to 6 ribs attached to the cervical vertebræ, and the opposite ends of which are not connected to the *sternum*. These, which have been named cervical ribs, form a transition to the rudimental ribs of the SERPENTINE family, which are larger in the neck than elsewhere. The sternum of the crocodile consists of two parts,—an anterior or thoracic, which is osseous, supporting the two collar-bones,—and a posterior or abdominal, which is cartilaginous, and extends to the *pubis*, and furnishing to the abdominal parietes eight cylindrical cartilages. In the East India crocodile it appears that these lateral processes are converted into a single broad piece of cartilage on each side. (Fig. 4.) Ribs.

The ribs of the CHELONIAD family are represented by the dorsal shell, which consists of eight broad incurvated plates, identified behind with the dorsal vertebræ, and terminating before in the margin of the shell, and which are doubtless genuine ribs. In the ordinary land-tortoise (*Testudo Græca*) these are seen in the shape of elevated bony ridges, proceeding from the head of each rib in a transverse concave bend to the margin of the dorsal shell. On each side of these ridges the bone is depressed, and is united at its lowest point by a genuine suture with the adjoining ones. These sutures, however, are not continuous with those of the sterno-abdominal shell, but meet it in the intermediate points. (Fig. 5.) The sterno-abdominal shell consists, in like manner, of several transverse pieces consolidated into one. The ordinary number is eight on each side of the mesial plane, and a ninth azygous, generally placed in the centre of the shell. In a specimen, however, of the tabular tortoise (*Testudo tabulata*), in our possession, the number of the sterno-abdominal pieces is 11, of which 8 are in pairs, united on the mesial line from before backwards, and 3 azygous at the posterior tip of the shell. In young animals it is easy to recognise the unions of these constituent bones, which consist of sutures ex- Dorsal and sterno-abdominal shells of the Cheloniad.

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actly similar to those of the cranium in the MAMMALIA. So feeble is the union, that it often happens that the abdominal shell especially separates at the lines of junction, in the attempt to detach it from the dorsal.

The BATRACHOID REPTILES, though void of ribs, are provided with a *sternum*, which before is a cartilaginous process, terminating on a disc placed below the larynx, where it receives the collar-bones, and forms behind a broad plate placed below the abdomen, and giving attachment to the muscles. In the Salamander tribe, which are without *sternum*, the ribs consist of twelve pair of small rudimental processes, articulated with the vertebræ, but admitting of very limited motion.

Lastly, in the SERPENTINE family, though there is no sternum, the upper vertebræ are provided with costal processes, quite rudimental. The great number of these costal rudiments, amounting in the rattlesnake to 175, in the *cobra di capello* to 192, in the *coluber natrix* to 204, and in the *boa constrictor* to 252, and the freedom of their anterior extremities, enable the animals of this tribe, which are destitute of locomotive members, thoracic or abdominal, to employ the spinal column and the ribs as organs of progressive motion. On this point the reader will find some interesting observations by Sir Everard Home (*Phil. Trans.* 1812, p. 163). In the region of the neck, where the ribs acquire peculiar length, they are employed in erecting that region, and producing the expansive swelling peculiar to this tribe of animals. It is an important link in the same series of facts, that in the animal absurdly named the flying lizard (*draco volans*), the five posterior ribs are recurvated and elongated to form the bony skeleton of the membranous sails by which the animal supports itself in its desultory flight from tree to tree.

Thoracic extremities.

It is in the SAURIAL family that the locomotive extremities of Reptiles ought first to be studied. In these we find an elongated *scapula* without spine, and one short flat bone, constituting the clavicle, united to the sternum. In the iguana and chameleon this bone is broad and nearly quadrilateral, while in the tupinambis it is large and oval-shaped, with its greatest length from before backwards, and with two unossified points.

In the RANINE tribe, while the *scapula* consists of two articulated pieces, the upper towards the spine, each shoulder is provided with two collar-bones attached to the two extremities of the sternum, and the two anterior of which correspond to the bifurcated bone of birds. The *sternum*, collar-bone, and first part of the *scapula*, form one piece. In the salamander, in which the same consolidation is observed, the scapular portion is most distinct and directed to the spine, while of the clavicular portion the part connected to the sternum stretches below the chest, but, without uniting with that of the opposite side, the right glides over the left,—an arrangement which facilitates the dilatation of the chest during inspiration.

A nearer approach still to the bifurcated bone than is seen in the RANINE may be recognised in the CHELONIAD family. In these animals three bones are united to form the humeral cavity. The first is a flat, trilateral bone, situate below the abdominal and thoracic *viscera*, close to the abdominal shell, and which, notwithstanding its situation, is evidently the *scapula*. The second is a bone about the same length, flat, and like the feather of an oar at one extremity, which is free, round in the middle, and flattened in the opposite direction at the other end, which is firmly united at a right angle to a long slender cylindrical bone. At the angle of union of these two bones is part of the glenoid cavity, which is complete in the small end of the scapula. The first of the two bones is the collar-bone proper; the second is the lateral branch of the bone, which forms the bifurcated, and which is occasionally united with its fellow. (Plate XXXIV. fig. 5.) The abdominal shell we have already stated to represent the sternum or breast-bone.

The *humerus* in the SAURIAL and CHELONIAD family is arched and incurvated in a serpentine direction. It is articulated with a *radius* and *ulna*, which are succeeded by three rows of carpal bones, one row of four metacarpal bones and digital phalanges, varying in number in different *genera*. In the skeleton of a fossil animal belonging to the SAURIAL tribe, originally delineated by Collini, and afterwards by Cuvier, and named by him the *Pterodactyle* or Wingtoe (*Pterodactylus*, *OSSEMENS FOSSILES*, tome v.), the metacarpal bone and *phalanges* of the *index* are prolonged to about twenty times the ordinary length, for the purpose, apparently, of giving attachment to the membranous web by which the animal occasionally elevated itself into the atmosphere. This animal, which, like the dragon (*draco volans*) of modern times, must have combined the contradictory characters of a flying reptile, may be regarded as forming the link between the REPTILES and BIRDS, as the *Ichthyosaurus* does between REPTILES and FISHES.

Fossil skeleton of winged reptile.

Pelvis.

In the *pelvis* of the CHELONIAD family it is remarkable that the pubal and iliac bones appear to change places. Thus the *ilium* on each side is a narrow bone proceeding backwards to the sacral part of the spine, which is received between its posterior aperture; while the *pubis* appears in the shape of a broad, trilateral, flat bone, uniting before with its fellow on the mesial plane, behind with the *ilium*, and below with a flat, thin, quadrilateral bone, corresponding to the *ischium*, with which it forms the oval aperture. The inner of these three bones presents, as usual, the cotyloid cavity. It is further to be observed, that the two iliac bones, and consequently the whole *pelvis*, are movable on the vertebral column. (Plate XXXIV. fig. 5.)

Pelvic extremities.

In the SAURIAL Reptiles the pelvic bones are arranged and shaped nearly as in the CHELONIAD. In the RANINE the iliac bones are much elongated, and the pubal and ischial are consolidated into one piece, the symphysis of which forms a rounded crest.

The *femur* is short, thick, and incurvated sinuously, with the convexity before towards the tibial end, and the concavity towards the pelvic. Trochanters, though present in the CHELONIAD, are wanting in the SAURIAL and RANINE Reptiles. In the leg we find both *tibia* and *fibula* distinct, and of nearly equal size, in the CHELONIAD and SAURIAL family, but conjoined in the RANINE family. The *tarsus* consists of five bones, and sustains four or five metatarsal ones, on which are supported three rows of phalanges. The metatarsal bones, which vary in length, are longest in the crocodile and others of the LACERTINE tribe. In the RANINE, again, the *astragalus* and *calcaneum* are the bones of greatest proportional length.

The anatomical characters now enumerated are proper to the skeletons of Reptiles at present existing on the surface of the earth or in its waters; and in these we find a gradual transition from the SAURIAL and CHELONIAD, by means of the SERPENTINE, to the finny inhabitants of the ocean. Even the BATRACHOID Reptiles, in the early period of their existence while tadpoles, we shall have occasion to see, approach to the FISHES; and in one singular genus, if not two, the *Proteus anguinus* and *Siren Lacertina*, the characters of the Reptile are combined with those of the Fish, in having at once lungs or internal respiratory cells, and gills or external ciliated branchiæ. The transition thus indicated is still more strongly demonstrated in the osteological characters of two *Genera* of animals now extinct, so far as is yet known,—the *Ichthyosaurus* and the *Plesiosaurus*.

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Osteological peculiarities of the Ichthyosaurus

From the specimens of the *Ichthyosaurus* hitherto discovered, it appears that the number of vertebræ varies from 80 to 90 or more; in one entire specimen they amounted to 104 (Conybeare and De la Beche); that they are flattened, with the transverse diameter greater than the longitudinal, and the two articulating surfaces of the bodies calycoid or cup-shaped as in Fishes. Though the annular part is distinct from the body, it is united to its sides. The spinous processes, which are long and prominent, form a continuous ridge above the spine, and are connected to each other by a process from the front of the one spine, which is inserted into a pit in the back of the other. Instead of proper transverse process, a certain number of the vertebræ are provided with two tubercles on each side of the body, of which the superior, convex, is articulated to the tubercle of the rib, while the other, which is concave, receives the head. In the inferior part of the vertebral column, these two tubercles, after approximating, are eventually identified into one.

The ribs, which are numerous, and extend from the *occiput* to the *pelvis*, are slender and trilateral in shape, bifurcated above, and attached to the vertebræ by a head and tubercle. In the perfect specimen of Mr de la Beche they amount to 31, and of these 17 appear to be cervical or anterior false ribs, with single tubercles; thus affording another mark of resemblance to the Saurial family in osteological characters.

The bones of the head, distinguished by the extraordinary size of the orbit, are similar to those of the Saurial Reptiles. The *sternum*, collar-bone, and scapula, though also similar to those of this family, bear a much closer resemblance to the figure of these parts in the *Echidna* and *Ornithorhyncus*. The *humerus* is short, thick, and sinuated; the bones of the fore arm flat, and probably constituting part of the fore or thoracic fin. The *Carpus* consists of three rows, the first containing three bones, the other two, four each. These are followed by five or six rows of flattened, irregularly cuboidal bones, gradually diminishing in size and number to the tips, and which represent at once the *metacarpus* and *phalanges* of the fore paw, used apparently chiefly as a fin or paddle. The pelvic extremities appear to have been less strong and perfectly constructed than the thoracic. The *femur* is smaller and shorter than the *humerus;* the *tibia* and *fibula* are flattened like the *ulna* and *radius;* the *tarsus* consists of two rows only, the first containing three, and the second five bones; and this in like manner terminates in five ranges of flattened bones, gradually diminishing in size, and which represent the *metatarsus* and metatarsal phalanges of the hind paw or paddle.

and Plesiosaurus.

From the specimens hitherto discovered of the *Plesiosaurus*, it appears that the total number of vertebræ amounts to 90, of which 35 appear to be cervical, while the other 55 are dorsal and caudal, the regions of which are proportionally short. The head of this animal also is small and compressed, nor has it the large orbit of the *Ichthyosaurus*. Each rib consists of a vertebral and sternal portion, united at an obtuse angle, the former articulated by a single head to the transverse process, and the latter connected with its fellow by a transverse slip, so that the lower or abdominal ribs appear to have surrounded the abdomen with a complete cincture. The anterior part of the chest is occupied by two trilateral bones uniting in the middle, which, from their connection with the scapula, are believed to be the coracoid bones; and above these is a transverse piece, with a middle notch and lateral sinuated elevations, which is regarded as the *sternum;* while the *scapula* extends on each side like a buttress between the two. It is not improbable, nevertheless, that the middle portions named coracoid bones are the sternum, and the transverse bone the clavicles; and it is worthy of remark, that not only this bone, but the middle piece, closely resembles in figure and disposition those of the *Echidna* and *Ornithorhyncus*. The *pelvis* consists of three bones, a vertebral or superior, corresponding to the *ilium*, narrow and slightly incurvated; an anterior, ascending forwards, and broad, separating the *pubis;* and a posterior, short, forming the *ischium*. The humerus and femur are longer than in the *Ichthyosaurus*. There is a very short *radius* and *ulna*, and *tibia* and *fibula*, articulated with five carpal and tarsal bones; and the rest of both paddles consists of successive rows of flattened but long bones, contracted in the middle, and expanded at the extremities, representing the metacarpal and metatarsal digital phalanges. (Home, *Phil. Trans.* 1816, 1818, 1819, 1820; De la Beche and Conybeare, *Geological Transactions*, vol. v. p. 559; and Cuvier, *Ossemens Fossiles*, vol. v. part ii.)

SECT. IV.—OSTEOLOGY OF THE FISHES.

The Serpentine or Ophiad Reptiles present in their osteological characters an approximative transition to those of Fishes. While in the former order the skeleton is reduced to the spinal column, ribs, and head, in the latter class the spine and head only are left; and in some tribes the transition is still more distinctly marked by the presence of ribs.

Vertebræ.

The vertebra of a fish is distinguished from that of any other animal by the shape of its body. The cephalic and caudal, or anterior and posterior surfaces, are hollow cup-like cones, so that the union of each two vertebræ forms a double conical cavity, united by the base, containing a substance composed of concentric fibro-cartilaginous layers, with intermediate albuminous or gelatinous matter. By this cartilage the vertebral bodies are united; and on this the motions of the spine are effected. This motion, however, is chiefly lateral; for the spinous processes are so long, and the articulation so complex, that antero-posterior inflection or extension is nearly impracticable.

In the cartilaginous fishes, for instance the shark, sturgeon, and lamprey, the vertebral bodies form simple tubes, which, from the extreme elasticity of the constituent cartilage, propel the contained fluid to a considerable distance. Thus Sir E. Home saw the fluid projected to the height of four feet from the intervertebral cavities of the shark. (*Phil. Trans.* 1809.) In this order, also, the spine is infinitely more flexible, and its resilient power, when bent by the muscles, is almost incredible. On each side, also, the vertebræ are excavated, to form a canal for lodging the large blood-vessels.

The vertebræ of fishes are numerous, and not easily distinguished into classes. They may, however, be distinguished into two, according as the spinous process is above only, or above and below at once. Those with the dorsal spine only are denominated *dorsal or abdominal vertebræ*, and have commonly at the sides transverse processes for the attachment of the ribs. Those with the dorsal and ventral spines are distinguished as the *caudal vertebræ*. The last caudal vertebra is generally trilateral, flattened in the vertical direction; and its tip is marked with articular pits, which indicate the attachment of the small elongated bones which sustain the caudal fins.

The number of vertebræ varies. In the *uranoscopus* or star-gazer there are only 25, in the *balista* 17, and in the four-spined trunk-fish (*ostracion*) only 13; while in the sturgeon the number is 84, in the eel 115, and in the shark 207.

Though Fishes have no chest, and require none, since their respiratory organs are gills, all of them are not void of ribs The ray, shark, *syngnathus*, *tetraodon*, *diodon*, *cy-*

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clupterus, *fistularia*, &c. have indeed no vestige of rib. But in the sturgeon, *balista*, eel, *uranoscopus*, *pleuronectes*, sea-wolf, and dory, they are in the shape of short rudimental processes; in the *trigla* and *loricaria* their sides are horizontal; in the perch, carp, pike, and *chetodon*, they encompass nearly the whole upper region of the abdominal cavity; and, lastly, in the silver-fish (*zeus vomer*), the herring, rhomboidal salmon, &c. they are united to a sternum. In the little animal named sea-horse (*syngnathus hippocampus*), several series of osseous tubercles of the skin, surrounding the body like belts, are supposed to represent false ribs. The sternum is limited to a small number of FISHES. Besides those already mentioned, in the dory there is a series of minute flat bones disseminated along the lower edge of the belly, which is supposed to represent a rudimental sternum.

In size and number the ribs vary, though in the *silurus*, carp, and *chetodon* they are of largest proportional size; in the herring they are as fine as hairs.

The head. Cranium.

The head in the finny tribes is more an object of zoological than anatomical description. The chief points to be remarked are, that the cranium forms but a small part of the head; that the orbits are separated by a *septum*, sometimes membranous, occasionally, as in the wolf-fish, bony; and that there is on each side a large movable bone, corresponding to the quadrilateral of BIRDS, not square, however, but oblong, which supports not only the lower jaw and palatine arches, but the gill-cover. In the cartilaginous fishes the sutures are early obliterated, and the cranium consists of an inseparable mass of cartilage. In the bony fishes the cranium is separable into numerous pieces, and in the perch they amount to 80. In the cranium of fishes the anatomist recognises more distinctly than in the superior orders the formation according to the vertebral type. Small in proportion to the whole head, the cranium appears like a direct continuation of the vertebral column. In the osseous division of the class especially, the cranium may be distinguished into the occipital or posterior vertebra, the spheno-parietal or middle, and the frontal or facial vertebra. The cavity thus formed is very small; yet small as it is, it is not exactly filled by the brain, between which and the bones there is interposed a pellucid fluid, contained in fine cellular tissue. The cranium of the osseous fishes also is widest between the ears, because the organ of hearing is contained within its cavity with the brain. In the cartilaginous it is quite different.

Locomotive members or fins.

Though FISHES are destitute of extremities similar to those possessed by the other three classes of the VERTEBRATA, they are not, however, without locomotive members. The thoracic extremities are represented by the pectoral fins, and the pelvic by the ventral. In short, it may be said that the bones of the thoracic and abdominal extremities are converted into osseous rays in the finny tribes.

Pectoral fins.

In the Ray *genus*, in which the wing-like disposition of the pectoral fins gives the body a rhomboidal shape, they consist of numerous radiating cartilaginous lines, all attached to a cartilage parallel to the spine, divisible into two or three others, and articulated above to another adherent to the spine. Below there is a strong transverse bar common to the cartilages of both fins, and separating at once the sternum and clavicle. This transverse bar is also seen in the shark tribe; but their pectoral fins, which are much smaller, are not articulated with the spine.

In the osseous fishes, and in many others usually referred to the cartilaginous division, *e. g.* the *balista*, the pectoral fins are fixed to an osseous belt, which surrounds the body behind the gills, and which supports the posterior margin of their aperture. This belt consists of a single bone on each side, articulated to the posterior-superior angle of the cranium, and uniting below the breast with that of the opposite side. This bone, which may be regarded as a *scapula*, varies in shape and the angle which it forms with its fellow in different species. In fishes flattened vertically, the angle of union is acute; in those which are depressed, the angle is so obtuse as to form nearly a straight line. In many fishes, especially those of the order THORACICI, *e. g. pleuronectes*, *cottus*, *zeus*, *chetodon*, perch, &c., in the small unicorn (*balista*), and others, the superior part forms a large spine, which descends immediately behind the fin, and to which the *adductor* muscles are attached. This spine, which is movable, has been improperly named a *clavicle*.

The rays by which the membrane is supported are not directly articulated to this belt, but are connected by a row of minute flat bones, which may be compared to the *carpus* in the other three classes. When the first ray of the pectoral fin, however, is thorny, as in the harness-fish (*loricaria*), and some species of *silurus*, it is articulated directly with an osseous belt; and it is remarkable that some fishes, as the *silurus* and stickle-back, have the power of retaining this spinous ray erected against the body as a means of defence. This is effected by a cylindrical tubercle, on which the spinous ray is articulated by a hollow, bounded before and behind by an elevated process. When the spine is erected, the anterior process, entering a hole in the cylindrical tubercle, is locked in it by the spine revolving slightly on its axis, so that it cannot be inflected unless by the spine revolving in the opposite direction.

Pterygoid pectoral fins.

The pectoral fins are so long that they answer the purpose of wings in several species of *trigla*, the *trigla hirundo*, the flying gurnard (*trigla volitans*), the springing gurnard (*trigla evolans*,) in the *scorpæna volitans*, the tropical flying fish (*exocœtus volitans*), and some others. Their situation also is liable to vary. In the *exocœtus* they are near the gills, but in the *blennius* and others they are remote. Lastly, they are totally wanting in a small number only, as the lamprey (*petromyzon*), the hag-fish (*myxine*, Lin.; *gastrobranchus*), the *murœna*, the eel *genus*, the *sphagobranchus*, &c.

Abdominal or ventral fins.

The abdominal or ventral fins, which correspond to the pelvic extremities of the other classes, are so denominated because in the majority of fishes they are situate below the belly, and nearer the anal outlet than the pectoral. By this circumstance a numerous order are distinguished by the name of Abdominal Fishes (ABDOMINALES).

In a small number of fishes, comprehending the *gadus*, *blennius*, *kurtus*, *callionymus*, *trachinus*, and *uranoscopus*, the ventral fins are placed under the throat, below the aperture of the gills, and before the pectoral fins. This order is therefore distinguished by the name of JUGULARES.

In the most numerous order of all, the ventral fins are situate behind and below the pectoral fins. These have therefore been denominated Thoracic Fishes (THORACICI).

The ventral fins consist of two parts—one formed of rays covered by a double membrane, apparent externally, and constituting the proper ventral fin; the other internal, representing the coxal bones of the *pelvis*, always supporting the pinnal rays, and often articulated with the bones of the trunk. It is never articulated, however, with the spine, nor does it form an osseous belt round the abdomen. The bones of which it consists are generally flattened, varying in shape, and in mutual contact by the internal margin. In the shark and ray *genera* only is there a single transverse bone, nearly cylindrical, to the extre-

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Ventral fins.

mities of which the fins are attached. The direction of the pelvic plane to the walls of the abdomen varies according to the shape of the body of the fish. In the flat fishes they are directed obliquely, and their inner margin forms the keel of the belly. In fishes with a broad or cylindrical belly they form a plane more or less horizontal.

In the Jugular and Thoracic Fishes, the pelvic bones are always articulated with the base of the belt which sustains the pectoral fins; and they vary much in shape and situation.

In the *trachinus*, *uranoscopus*, *cottus*, *sciæna*, *chetodon*, and perch, these two bones are united by their inner margin. In the cuckoo-gurnard, in which they are united by the posterior tip only of their internal margin, they are broad, flat, and oval. In the sole and flounder *genus* (*pleuronectes*), in which the fins are attached to their anterior tip, they are united in a quadrangular pyramid, the apex of which is directed backwards and upwards, and the base forwards. In some of the stickle-backs these bones are altogether separate, and being long, receive in their middle a movable spine, which supplies the place of the ventral fin. In the dory (*zeus faber*, L.) they are flat and triangular, in mutual contact by their whole surface. In the silver-fish (*zeus vomer*) they are small and cylindrical.

In the whole of the Abdominal order, on the contrary, the pelvic bones are equally unconnected with the bones of the shoulder and with the osseous belt of the pectoral fins, and are confined to the middle-inferior part of the belly, not far from the *anus*. In general these two bones are separate from each other, and are retained in their situation by ligaments. In the carp, in which they are elongated, they touch only by their posterior third. In the herring, in which they are small and approximated, they are continuous with the minute bones of the sternum. In the pike they are broad and trilateral, approximated by their anterior tips, separate behind where the fin is attached. In the *silurus*, in which they are united, they form a round and often spinous shield before, while the fins are attached to the exterior-posterior margin. Lastly, in the cuirassier or harness-fish (*loricaria*), the pelvic bones are united in one piece, the posterior notch of which forms the anal aperture, while the fins are attached to its external margin.

The proper fin consists of a certain number of osseous rays, simple or bifid, supported by one or two rows of minute bones placed between them and the pelvic bones. On these small bones the constituent rays move, diverging or converging like the rods of a fan, while the whole fin may be inflected or extended by the minute bones moving on the pelvic, so as to adduct or abduct the fin.

In the cartilaginous fishes the structure is different. To the tip of each pelvic bone are articulated two principal cartilages, one external, forming a kind of toe with seven or eight joints; the other internal, supporting all the other rays of the fin, which often exceed thirty in number.

Analogy or unity of principle in organisation.

If we suppose these bones, like the minute ones of the pectoral fin, to represent the *tarsus* of the other three classes, it must follow that, in the locomotive extremities, the *humerus*, with the *ulna* and *radius*, and the *femur*, with the *tibia* and *fibula*, are obliterated. It is not unimportant to observe, that the general structure of the Vertebrata tends through various transitions to this termination. In the Amphibia the long bones of the extremities are shortened by removing the *diaphysis*, and leaving their articulating ends only. In the Cetacea the pelvic extremities are removed altogether. In the Cheloniad and Saurial Reptiles the same long bones of the extremities are much abridged; and in the Ichthyoid Reptiles, now extinct, but sharing by their structure a form of animal existence partaking of the reptile and fish at once, and perhaps intermediate between the two, this abbreviation is carried perhaps to its greatest possible degree, in leaving the articular ends only of the four locomotive extremities. Lastly, this reduction is merely preparatory to that exhibited in the whole class of Fishes, in which the three longitudinal bones so conspicuous in the higher classes of animals are completely obliterated, and those representing the hand or forepaw and foot are articulated directly to the shoulder and pelvic bones.

Besides the bones already mentioned as constituting the skeleton, there are observed in the osseous fishes minute bones, generally fork-like in shape, disseminated through all the muscular parts of the body. The purpose of these bones, which, as being totally insulated from the other parts of the skeleton, are denominated *ossicula musculorum*, is chiefly to afford points of support; and they are probably to be regarded as rudimental representatives of osseous parts, more completely developed in the higher animals.

Violation of the law of symmetry.

It is further a curious circumstance, that the skeleton, which is so symmetrical in all the other classes and orders, begins to exhibit a deviation from this first in the skeleton of the finny tribes. In the Sole *genus* (*Pleuronectes*) this deviation is very conspicuous. Both eyes are placed on the same side of the mesial plane; and the side on which the eyes are placed is broader than the opposite one. The former is bounded by a convex margin, the latter by a concave one. The orbit towards the former is large, the other small and imperfect. Conversely, it is to be observed, that in the latter the maxillary and intermaxillary bones are larger than in the former. The sides of the inferior jaw are less discordant; and though in the Sole and Plaice those of the eyeless side are more straight and elongated than those of the other, in the Turbot (*Pleuronectes maximus*) they are nearly symmetrical.

CHAP. II.—COMPARATIVE MYOLOGY.

Though this is the proper place to consider the peculiarities of the muscular system of animals, the limits assigned to this sketch will not allow us to enter into details. We shall merely, therefore, take a cursory view of those points in which the myology of the lower animals differs from that of the human subject.

In general, in the lower animals, especially the Mammalia, Birds, and Reptiles, the muscles correspond in situation to those of the human subject; and whatever modifications they undergo consist in changes of figure, and in some few instances in changes in attachment. The former kind of changes may be in all cases pretty accurately estimated by the osteological characters of the class, order, or genus; for when the position, shape, or direction of a bone is altered, in the same proportion nearly are the attached muscles altered in their attributes.

Deficiency in number.

Though in the lower animals, however, the zootomist traces muscles in general quite analogous to those of the human subject, in several instances this analogy ceases to be observed. In general the muscles of the lower animals are less numerous than those of the human subject; and this deficiency in number, though not much observed in the Quadrumana, is very remarkable in all the inferior orders of the Mammalia, and still more in the Birds and Reptiles. In general, also, these variations are most conspicuous in the locomotive extremities. Thus the small pectoral muscle, which is present in the Quadrumana, is wanting in the Carnivora and the whole of the Ungulated Animals and the Reptiles. The short *supinator* is present in the Canine and Feline *genera*, but the long is wanting; and both are absent in the Chiroptera, Rodentia, Pachydermata, Ruminantia, and

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Solidungula, and in the whole class of Birds. Both pronators (*teres* and *quadratus*) are present in the Quadrumana and Carnivora, but wanting in the Chiroptera, Ruminants, and Solidungula. The Rabbit, and perhaps the Rodentia generally, have the *pronator teres;* but as the radius is not very movable, its influence is trifling.

Myological peculiarities of the mole.

In the mole the *rhomboideus* is inserted into the cervical ligament, which is ossified; and it therefore elevates the head and neck on the *scapula* with singular force. This is effected still more remarkably by the occipital part of the *rhomboideus*, the fibres of which being parallel to the spine, pass below the proper *rhomboideus* to be attached to the transverse ligament and the middle of the *cranium*. The strong, thick, quadrangular collar-bone has two muscles, a *supraclavius* and a *subclavius*. The large pectoral is very thick, and nearly as large as in birds.

The common extensor of the fingers or fore toes is the only muscle which is common to man and all the quadrupeds. Of the proper extensors the horse has two on the side of the common extensor, but acting as an extensor of the fore pastern; another between the common extensor and the extensor of the pastern, and which seems merely an appendage to the former. The proper extensor of the index is wanting in the Rodentia, Ruminants, and Solidungula; and while the two latter orders are destitute of the long and short extensors of the thumb, and the feline, canine, ursine, and leporine *genera* have the former, they are destitute of the latter. Lastly, the lower animals are wholly destitute of the short muscles of the hand, which in man produce flection, abduction, adduction, and opposition. In the Chiroptera only is there one extensor, and flexors of the fore toes.

Among the muscles of the pelvic extremities the *glutæus maximus*, or large muscle of the buttock in man, diminishes much in the Quadrumana; and in the other orders is reduced to a very small size. The buttock in the Mammalia generally consists chiefly of the *glutæus medius* and *minimus;* and while the *glutæus maximus* is in the horse in a great part aponeurotic, the *g. medius* is so large as to produce those forcible and sudden extensions of the hind leg which constitute the kick.

In the leg the *sartorius* of the horse, the animal in which the muscles have been most studied, is large, and is distinguished by the name of the long *adductor*, in opposition to the *gracilis*, which constitutes the short *adductor*. The muscle representing the *biceps* of man is in all quadrupeds a *uniceps*, and the single head is attached to the ischium only. In the horse and dog it has been denominated the *vastus longus*.

The *gastrocnemius externus et internus* (*gemellus*), which constitute the calf of the human subject, diminish considerably in the lower animals; and the *solæus*, which is placed below them, also becomes small, and is particularly slender in the Ruminants and Solidungula.

Muscles wanting in birds.

The following muscles are wanting in the whole class of Birds. The diaphragm, the *recti abdominis*, and the *pyramidales;* the muscles of the dorsal part of the spine, the *splenius*, the *brachialis externus*, or third head of the *triceps;* the supinators of the fore arm or wing, as already mentioned, all those corresponding to the short muscles of the hand and fingers; the *quadratus lumborum*, the *psoas parvus*, the *psoas magnus*, *iliacus internus*, *obturator externus*, and the *extensor longus pollicis pedis*.

Two muscles, which occupy the situation of the pronators, act as flexors, showing the connection between the actions of inflection and pronation, and the occasional substitution of the latter for the former.

In this class, also, the *glutæus maximus* is of a pyramidal shape, while the true *pyriformis* is wanting. The *glutæus minimus*, which is attached to the anterior edge of the iliac bones, is the *iliacus*. In place of the *pectineus* there is a slender muscle, which extends to the knee, over which its tendon passes, and gliding behind the leg, its tendon is bifurcated, one slip going back to be inserted into the posterior part of the metatarsus, the other to be united to the perforated flexor of the first and last toe. This muscle, which is named the *accessory femoral flexor*, is the one by which birds are enabled to clasp a perch during sleep.

Muscles used in flying.

In Birds the great pectoral is a remarkable muscle in point of size. It consists indeed of three muscles, the large pectoral, the middle, and the small, which occupy the sides of the vertical crest of the sternum, and constitute what is named the breast of the animal; and which are chiefly employed in the energetic motion of the wings in flying. These muscles are sometimes so large that they weigh more than all the other muscles of the animal together. In birds which fly much they are dark coloured and firm; in those which fly little, as the domestic poultry, they are white coloured, and in general soft. The same distinction is observed in the muscles of the two extremities. In birds much on the wing these muscles are dark coloured and firm, while those of the legs are comparatively lighter and more tender; and, conversely, in birds little on the wing and mostly on the legs, as the domestic poultry and many of the *Grallæ*, the waders, swimmers, &c. the muscles of the wings are light coloured and tender, while those of the legs are dark coloured, firm, and strong.

Mechanism of perching.

The flexor muscles of the leg and toes of Birds merit notice. They consist of muscles corresponding to the long flexors, which are divided into three masses. The first consists of five portions, three of which may be regarded as constituting a single *common perforated flexor*. It rises by two bellies, one attached to the external condyle of the *femur*, forming a perforated tendon, which receives one of those of the muscle corresponding to the *peronæus;* the other to the posterior surface of the femur, forming the tendons of the index and small toe. This muscle is further connected by intermediate fibres with the accessory femoral flexor,—a muscle placed on the internal surface of the thigh, and sending its tendon over the knee; and as the tendons are inserted into the unguinal phalanges, when the accessory femoral bends the thigh the flexors of the toes inflect them also, and retain them in the inflected position. By means of this arrangement birds are enabled to clasp a perch or other small body when roosting, without continued muscular effort, and thereby to sleep on the perch. This mode of explanation, which was originally given by Borelli, has been controverted by Vicq d'Azyr; but apparently not on good grounds.

Among the class of Reptiles, while the muscles of the Ophidial family are confined to those of the vertebræ and rudimental ribs, in the Cheloniad these are obliterated, and the muscles of the neck, head, and tail, and those of the locomotive extremities alone, are left. In the other two classes of reptiles the muscles are in general analogous to those of the Mammalia.

Cutaneous muscle.

There are not many instances of muscles which, though unknown in man, are found in the lower animals. Of these the most remarkable are the cutaneous muscle (*panniculus carnosus*), and the suspensory of the eye. The former was absurdly maintained to exist in the human subject, especially by Nicolaus Massa; but it is manifest that the assertion was derived from the dissection of the lower animals only. It was not long after demonstrated by Charles Etienne, that no fleshy pannicle or cutaneous muscle exists, such as is found in the lower animals; and

that the only cutaneous muscles in man are the *latissimus colli*, the *epicranius* or scalp-muscle, and those which are attached to the face, and which by their motion give expression to the countenance. The cutaneous muscle even is not found in the QUADRUMANA, nor does it exist in the pig. In various other animals, however, it is found in different degrees of distinctness. It is very well marked in the hedgehog and porcupine;—by its means they have the power of erecting their spines, and rolling themselves up;—and in the armadillo and the ant-eater tribe. In the mole, also, we have seen it pretty well marked.

Suspensory muscle of the eye proper to certain animals.

It is an interesting fact, that Galen originally observed that the lower animals possess a seventh muscle of the eye, or one more than man. The suspensory or infundibular muscle (*musculus choanoides*), as it has been named, from its shape, especially in the Ruminants and SOLIDUNGULA, has the *apex* fixed to the margin of the optic hole, and its base inserted a little behind the four straight muscles. In the ZOOPHAGA and CETACEA it consists of four parts, so that these orders appear to be provided with 8 straight muscles. In the rhinoceros it consists of two portions.

Tail,

There is yet another part, the muscles of which can scarcely be said to exist in the human subject, but which attain a very great degree of developement in the lower animals. The *coccyx* of the human subject is expanded in the lower animals into a highly flexible prolongation denominated the tail (*cauda*), variable in length, but always consisting of separate vertebræ, articulated and movable on each other. While the *coccyx* of the human subject possesses two muscles only, the *ischio-coccygeus* and *sacro-coccygeus*, which are so insignificant in size that they scarcely serve to move the part, the caudal vertebræ of the lower animals are moved by muscles greatly larger, more numerous, and more powerful.

The tail is to animals a much more useful and powerful organ than the coccyx to man. It is a member which peculiarly belongs to them; and though in ordinary circumstances pendulous, it is made to assume a variety of motions of which no other organ is susceptible, and to perform duties which would be otherwise impracticable. With many, as the long-tailed monkeys, the sloths, the ant-eater, and the squirrel tribes, it is indispensable as an organ of prehension. The majority of animals, as the Ruminants, SOLIDUNGULA, &c. use it as a whip or lash to drive away insects. The lion, tiger, and others of the feline tribe, lash their sides with it when enraged. The Cetaceous swimmers employ it as a rudder and oar in the waters. The beaver uses it as a trowel, to enable him to construct his clay-built dwelling. An organ employed so variously must consist of a muscular apparatus rather complex.

and caudal muscles.

The different motions of which the tail of the MAMMALIA is susceptible may be referred to three heads,—one by which it is extended or elevated, another by which it is inflected or depressed, and a third by which it is made to beat the sides. The combination or succession of these motions gives rise to secondary ones more complex in character. It may be twisted on its axis, or turned in a spiral direction. These motions are effected by three classes of muscles.

1*st*, The muscles which raise the tail are situate above; they are *musculi sacro-coccygæi superiores*. Commencing at the base of the articular processes of the 3 or 4 last lumbar vertebræ, or those of the sacrum and the caudal vertebræ, by fleshy slips, they are connected to tendons, which are inserted into the base of the first of the caudal vertebræ, which are void of articular processes. The second tendon goes to the next following vertebra, and so on to the 13th, each contained in a ligamentous groove, which forms an investment. The muscles of both sides acting together, elevate or incurvate the tail upwards.

The *interspinalis* and *spinalis obliquus* or lumbo-sacro-coccygeal are the continuations of the *interspinales dorsi et lumborum*. The spinous processes, however, becoming indistinct, or being represented by two tubercles, the attachments vary.

2*d*, The muscles which depress or inflect the tail downwards take their origin within the pelvis, and are prolonged to various extents along the inferior surface of the tail. Of these there are four pairs, the *ileo-coccygeal* of Vicq d'Azyr, the inferior *sacro-coccygeal*, the *inter-coccygeal* muscles, and the *pubo-coccygeal* of the same author. The insertions of these muscles vary in different genera, according to the number of vertebræ of which the tail consists. The pubo-coccygeal is wanting in the raccoon, but it is distinct in the dog and opossum. The effect of the ileo-coccygeal and it, is to depress the tail and apply it forcibly to the *anus*.

3*d*, There are only two muscles which carry the tail to the sides of the animal—the *ischio-coccygæus externus*, and the *intertransversalis* of Vicq d'Azyr; the former proceeding from the pelvic surface of the *ischium* below and behind the *acetabulum*, to the transverse processes of the caudal vertebræ, the second extending in a continued band between all the transverse processes.

The tail, therefore, in the MAMMALIA, consists of a series of successively decreasing vertebræ, moved by eight pairs of muscles.

In FISHES it is not easy to trace any analogy between the muscles and those of the other classes. Though the spine, head and fins, have appropriate muscular bundles, the natural or fascial distinctions are less evident than in the other three classes. It is important, however, to remark, that while the muscles which move the spinal column are placed in these classes, partly before, and chiefly behind the vertebræ, those of FISHES are placed on each side. Hence the lateral motion of the spine, which is inconsiderable in MAMMIFEROUS animals, BIRDS, and REPTILES, becomes very conspicuous in the finny tribes, especially in the motion of swimming, while the antero-posterior inflection or extension is altogether insignificant.

It is almost superfluous to remark, that, in the greater part of the finny tribes, the muscles are white or pale coloured. In a few only, for instance the salmon, trout, gwiniad (*coregonus*), herring (*clupea harengus*), carp (*cyprinus*), and some others, are the muscular fibres of a pale flesh red. The circumstances on which these differences depend are not known; but it is supposed that in the latter sorts the proportion of oleo-albuminous matter is more abundant than in the former. The proportion of albumen, however, in the muscles of fish, seems in general to be small. They abound in gelatine and isinglass; and in some of the cartilaginous fishes especially, the greater part of the muscles seem to consist chiefly of gelatine in various degrees of consistence. This is particularly the case with the lamprey, the hag-fish (*myxine glutinosa*), and even with the sturgeon. The sterlet especially (*acipenser Ruthenus*), a small species of sturgeon found in the rivers of Russia, both European and Asiatic, abounds in gelatine; and the presence of this principle enables the inhabitants to use it in the preparation of a species of soup, the sterlet, which is esteemed a great delicacy. In some of the *genus Pleuronectes* this principle is also very abundant. Thus the Plaice (*Pleuronectes Platessa*), sole (*P. Solea*), and especially the turbot (*P. Maximus*), contain a considerable proportion of gelatine. On the proportion of this principle depends the quality of fish used

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as an article of food in nourishing without exciting. All fishes which abound in gelatine uncombined with oleo-albuminous matter may be safely used as articles of food; while those in which the latter ingredients predominate are invariably eaten with the risk of disordering the stomach and producing indigestion.

CHAP III.—COMPARATIVE ÆSTHIOLOGY, OR THE COMPARATIVE ANATOMY OF THE ORGANS OF SENSATION.

SECT. I.—THE ORGAN OF SMELL.

The organ of smell consists of the nasal cavities, those of the ethmoidal and turbinated bones, and the frontal, sphenoidal, and superior maxillary sinuses, all of which communicate with the nasal. The whole of these parts are invested by fine periosteum, lined by mucous membrane. The ethmoid bone is the essential organ of smell; and the others appear simply to multiply the extent of the membrane.

The ethmoid bone consists of a perforated plate, with a middle vertical one attached at right angles to it, and lateral portions composed of thin bony plates convoluted with various degrees of complexity and minuteness in different orders and genera of animals. These convoluted plates form what are denominated the ethmoidal cells. They may be represented as numerous tortuous canals, proceeding from the perforated plate forwards and outwards, approximating mutually, and forming numerous communicating cavities. Such nearly is the structure of these plates in the EDENTATA, RUMINANTIA, SOLIDUNGULA, PACHYDERMATA, and CARNIVORA, the last of which have more complicated cells than the first. In the dog they are numerous and extensive. In the RODENTIA, for instance the porcupine, they are few—not above 3 or 4 on each side.

Ethmoid cells.

In BIRDS the internal side of each nostril is occupied by three orders of plates; the inferior turbinated or spongy bone; the middle, consisting of one plate convoluted on itself two turns and a half; and the upper, shaped like a bell, adhering to the frontal and lacrymal bones. These form three tortuous passages, varying in size and tortuosity in different *genera*. Though generally cartilaginous, these turbinated bones are membranous in the cassowary and albatross, and bony in the calao and toucan.

In the nostrils of REPTILES there are convoluted prominent plates, which, however, are merely membranous productions, unsupported by any bone.

In the FISHES, in like manner, there are membranous folds, the disposition of which is tortuous. They are, however, more regularly arranged than in the other classes. In the cartilaginous fishes they consist of semilunar folds placed in parallel tracts on each side of a broad plate, which divides the one side of the nasal cavity from the other. In the sturgeon, however, they are arranged in diverging plates, which are subdivided into more minute ones, like the branches of a tree. In the osseous fishes generally they consist of radiating plates disposed round a prominent central tubercle.

In these three classes the olfactory nerve is distributed to the membrane much in the same manner. This nerve, however, does not proceed farther than the superior turbinated bones; and the middle and inferior appear to be supplied with filaments of the fifth pair, the naso-ophthalmic branch of which is distributed to the nose in all the vertebrated animals. In the MAMMALIA, further, the spheno-palatine ganglion sends several filaments to the posterior part of the narine membrane.

By most zootomical authors the trunk of the elephant has been described as an organ of smell peculiar to that animal. We are satisfied, however, from observing the motions of this body in the living animal, that it is an organ, not of smell, but of prehension. Cuvier, after adopting the ordinary view, has relinquished it, and, on the ground of personal inspection, admits that the sense of smell in the elephant is confined, as in other animals, to that portion of the nasal cavities which is contained within the bones of the head. The trunk of the elephant, therefore, will with greater propriety be noticed under a subsequent head.

The nasal cavities of the CETACEOUS animals are not so much organs of smell as channels of respiration, and must also be noticed afterwards. It is sufficient here to remark, that in these animals the part of the cranium corresponding to the ethmoid bone is penetrated by no aperture, or, in other words, is not an ethmoid bone. It has therefore been asserted that the CETACEA have no olfactory nerve, and no sense of smell. This, however, is by no means established. Blainville and Jacobsen have observed in the dolphin nerves which they regard as olfacient; and Treviranus delineates nerves of the same character. By Otto and Rudolphi, on the contrary, who have had frequent opportunities of dissecting the dolphin and whale, the existence of these nerves is denied.

Though almost all the invertebrated animals give proofs of the existence of the sense of smell, in none of them do we find any organ in which this sensation appears with certainty to be exercised. That these animals possess the faculty of smell, is inferred from the fact, that insects recognise their food at a distance; that male butterflies scent the female even when inclosed in cages; and that the ordinary flesh-fly deposits her eggs on tainted meat, and occasionally on fetid plants, in the belief that they are the proper *nidus*, though in the latter case the *larvæ* perish for want of the necessary sustenance.

Smell in invertebrated animals.

Since odorous particles are evidently applied to the olfactory membrane of all aeropnoic animals by the medium of the atmosphere, and since the organ of smell is therefore situate in connection with the wind-pipe, it was conjectured by Baster, that, in insects at least, the organ of smell is situate at the entrance of the *tracheæ* or air-tubes. This conjecture derives some probability from the fact, that the inner tracheal membrane in these animals is soft and moist, and that those in which it is expanded into convoluted *lacunæ* and tortuous vesicles, for instance beetles, flies, and bees, are remarkable for the nicety of their sense of smell.

The *antennæ*, in which this sense has been placed by some anatomists, appear to be rather organs of touch than of smell.

In the MOLLUSCA the whole cutaneous covering seems to combine the character of an organ of touch or tact, and of smell. Like an extensive pituitary membrane, it is soft, villous, moist, and liberally supplied with nerves. The ARTICULATA and Zoophytes seem much in the same state. But on all these points information is rather conjectural than positive.

SECT. II.—THE EYES; THE ORGANS OF VISION.

All red-blooded animals, without exception, are provided with two movable eyes, consisting of the same essential parts as those of man, forming globular organs, and placed in the cranio-facial cavities named orbits. In none are there more or fewer; and the exceptions to the general rule, either in relation to the presence of these organs, or number, are only apparent. Among the MAMMALIA, indeed, there are two instances of blindness,—in the *zemni* or blind rat (*Mus typhlus*, Lin.; *Spalax typhlus*, Pall.), and the golden mole (*Talpa Asiatica*, Lin.; *Chrysochloris*, Lacep and Cuvier). But in neither of these animals are

Blind though not eyeless animals.

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the eyes absolutely wanting; they are merely very minute, and covered by a thin fold of hairy skin, in which there is said to be no aperture. Much in the same manner the *murœna coecilia*, and the hag-fish (*myxine*, Lin., *gastrobranchus cœcus*), though provided with eyes, are deprived of the use of these organs by the opacity of the *conjunctiva*. In the *Anableps* (*Cobitis Anableps*, Lin.), the *cornea* and *iris* are biparted by transverse bands, so as to give the animal the appearance of having two pupils in each eye, though the crystalline lens, vitreous humour, and retina, are single. This animal affords the only example of this structure among the vertebrated animals; but a similar arrangement is observed in the Cephalopodous Mollusca and cuttle-fish family.

Figure of the eye-ball.

The general shape of the eye depends on the medium in which the animal lives. It is nearly spherical, or approaching the spherical shape, in man and the quadrupeds moving along the surface of the earth; that is, in the lowest and most dense region of the atmosphere. The *cornea* merely forms a slight convexity, in consequence of being the segment of a smaller sphere than the rest of the eyeball; yet in the porcupine, opossum, &c., this difference is inconsiderable. To show the degree of this convexity, it is merely requisite to compare the axis or antero-posterior diameter with the transverse diameter of the ball, as exhibited in the following table:—

Axis and diameter.

	Axis.	Tr. Diam.		Axis.	Tr. Diam.
Man and ape	137	136	Whale	6	11
Dog	24	25	Porpoise	2	3
Horse	24	25	Owl	13	12
Ox	20	21	Vulture	13	16

According to the measurements of the younger Soemmering, the axis of the human eye, taken in a beautiful Tyrolese girl of 20, is to the transverse diameter as 100 to 95; that of the eye of the magot (*simia inuus*) as 85 to 84; and that of the bat (*vespertilio auritus*) as 12 to 11. In the raccoon (*ursus lotor*) and lynx (*felis lynx*) alone the axis is exactly equal to the diameter. In all the other vertebrated animals, it is, as in the measurements of Cuvier, less than the transverse diameter at the rate of from 9 to 33 or 45 per cent. In the horse it is as 186 to 212, in the seal as 130 to 142, in the Indian elephant as 135 to 180, and in the black whale (*balœna mysticetus*) as 20 to 29. In the owl it is as 17 to 18, in the golden falcon as $14\frac{1}{2}$ to 16, in the ostrich as 18 to $19\frac{1}{2}$, and in the swan as 7 to 10. In the Reptiles and Fishes it is always less at the rate of from 3 to nearly 10 per cent. In the cuttle-fish, which may be taken as a general example of the invertebrated classes, it is much greater, the axis being to the diameter as 80 to 57. (D. W. Soemmering *de Oculorum Hominis Animaliumque Sectione Horizontali Commentatio*. Goetting. 1818, fol.)

In Fishes and the Cetacea which inhabit the sea, the anterior part of the eyeball is much more flattened, and in many fishes it resembles a hemisphere with the plane surface before and the convex behind. In the ray *genus* the superior part is also flat, so as to give the eye the appearance of the quadrant of a sphere, cut through two large circles perpendicular to each other. In some fishes, especially the burbot (*Gadus Lota*), the *cornea* is convex.

In Birds which occupy the elevated regions of the atmosphere, the deviation from the spherical shape is in the direction opposite to that of fishes. On the anterior part, which is sometimes flat, sometimes shaped like a truncated cone, is chased a short cylinder, closed by a very convex, and occasionally hemispherical *cornea*, always belonging to a much smaller sphere than the posterior convexity.

Aqueous humour.

These differences in shape depend on the proportion between the density of the medium in which the animals live and that of the aqueous humour. In the higher regions of the atmosphere, in which the air is very much rarefied, the refracting power of the aqueous humour is much more considerable than at the surface, occupied by quadrupeds; and hence it is more abundant in the former than in the latter class. Its refracting power, however, would be almost extinguished in a watery medium, from which it could differ but little in density; and hence it is either trifling or absolutely wanting in the inhabitants of the deep. In the cuttle-fish family it is entirely wanting.

The crystalline lens in Fishes, which is nearly spherical, projects through the pupil, and leaves little room for the aqueous humour. The lens is also very convex in the Cetacea, the Amphibious Mammalia, the diving birds, as the cormorant, and the marine and aquatic Reptiles.

Affecting the oblate spheroidal shape in the Mammalia, it becomes extremely so in man, and still more in Birds. Its consistence is greatest in animals in which it is most convex; and hence it is matter of common observation, that the crystalline of fishes is particularly firm. It also contains rather more albumen than the lens of the Mammalia. The crystalline lens occupies least proportional space of the eyeball in man, and most in fishes.

The comparative spaces occupied by each of the humours may be understood from the following table, in which the axis of the eye, or the space occupied by the whole three humours, is represented by unity.

	Aqueous Humour.	Crystalline Humour.	Vitreous Humour.
Man	$\frac{5}{22}$	$\frac{4}{22}$	$\frac{15}{22}$
Dog	$\frac{5}{21}$	$\frac{8}{21}$	$\frac{8}{21}$
Ox	$\frac{5}{37}$	$\frac{14}{37}$	$\frac{18}{37}$
Sheep	$\frac{4}{17}$	$\frac{11}{17}$	$\frac{12}{17}$
Horse	$\frac{9}{43}$	$\frac{16}{43}$	$\frac{18}{43}$
Owl	$\frac{8}{27}$	$\frac{11}{27}$	$\frac{8}{27}$
Herring	$\frac{1}{7}$	$\frac{5}{7}$	$\frac{1}{7}$

On the proportion of the total volume occupied by each of the three transparent parts there are few accurate facts. It may be remarked, however, that the human eye among the Mammalia is that in which the vitreous humour is proportionally most abundant. It is estimated to be twenty times more copious than the aqueous. In the ox it is only ten times, and in the sheep nine times the quantity of the aqueous.

Sclerotic.

In the Mammalia generally, the sclerotic is comparatively elastic, soft, and yielding; but in all animals in which the eye deviates from the spherical shape, as the Cetacea, Fishes, and Birds, this membrane is strengthened by greater solidity and thickness of tissue, or supported by accessory parts of a hard unyielding structure.

In the eye of the whale these two parts, the hard and soft, are naturally distinguished in a very striking manner. The lateral parts of the sclerotic are nearly an inch thick, and very hard. The posterior part is about one and a half inch thick, and softer, because the spaces between the firm fibres are filled with oily substance. The posterior part presents for the optic nerve a canal one and a half inch long, the walls of which are formed chiefly by fibres in direct continuity with the *dura mater*,—the only fact, it may be observed, which favours the statement of the ancient anatomists, that the sclerotic is derived from the *dura mater*. The sclerotic of the porpoise, though only two or three lines thick, has the same structure as that of the whale. In the seal it is thick before and thicker behind, but the middle zone is thin and flexible.

Osseous zone of birds.

The sclerotic in Birds is thin, flexible, and elastic behind, with a bluish glistening aspect, and without distinct fibres. The optic nerve enters, not by a hole, but an oblique canal. The anterior part consists of two plates, between which is enchased a zone of thin, hard, oblong, osse-

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ous scales, varying in number from 11 or 12 to 14 or 15, imbricated over each other so as to give the anterior part of the eyeball a great degree of hardness, and a figure unsusceptible of change. Though these plates are nearly flat in most birds, and form an annular zone slightly convex, they are broad, arched, and concave internally in the owl *genus*, and form a bell-shaped tube, with the posterior aperture oval and the anterior round. This may be denominated the osseous ring (*annulus osseus, zona ossea*). In the ostrich it is narrow and flat.

and reptiles.

Among the REPTILES, the CHELONIADS possess an osseous zone, consisting of plates inclosed in the membrane without being continuous with its substance. They are also found at the lateral part of the sclerotic in the chameleon and some of the SAURIAL Reptiles, as the *Crocodilus Sclerops* and *Lucius*, the monitor, and the iguana (D. W. Soemmering). It is also an important character in the structure of the eye of the Ichthyosaurus, which indicates the connection of that animal with the SAURIAL tribe, that its sclerotic was provided with an osseous zone, consisting, as in these, of 13 separate pieces.

In FISHES the sclerotic is cartilaginous, homogeneous, semi-translucent, elastic, and, though thin, firm enough not to collapse. In the ray it is expanded into a tubercle, by which the eye is attached to a peduncle or stalk. The sclerotic of the sturgeon is so thick that it resembles a cartilaginous sphere, with the external part hollowed for the humours and membranes.

In the CEPHALOPODOUS MOLLUSCA it forms behind a truncated cone, with the apex at the bottom of the orbit containing the gangliform swelling of the optic nerve, and several glandular parts, with the eye before.

Cornea.

The *cornea* has often been represented to be merely a continuation of the sclerotic; and though this is easily disproved by accurate dissection of the human eye and that of our ordinary domestic animals, its inaccuracy is much more manifestly demonstrated in the animal world at large. In the whale and rhinoceros the margins of the two membranes penetrate reciprocally. In man and the ox the corneal margin is enchased within the sharp imbricated edge of the sclerotic. In the tope-fish (*squalus milandra*, Lin.; *galeus*, Cuv.) the cornea is observed distinctly passing within the sclerotic in the manner of imbrication. The cuttle-fish is destitute of cornea; and as there is no aqueous humour, the crystalline lens is covered by a fine thin membrane, extended beneath the conjunctiva.

Corneal conjunction.

In all animals provided with eyelids, the mucous membrane, after being folded behind the eyelids, is reflected forwards over the sclerotic and cornea, in the form of a thin, transparent membrane. In those void of eyelids, as most fishes are, the skin, passing into mucous membrane, is continued directly over the *cornea*, without forming any angular fold, and adheres strongly. This is very distinct in the eel, which may be flayed without leaving any trace at the site of the eyes, except a round, translucent spot. The same peculiarity is remarked in SERPENTS and in the cuttle-fish family. In the *zemni*, golden mole, blind eel, and hag-fish, it has been already stated that the cornea is covered by opaque mucous membrane.

Choroid coat and Ruyschian membrane.

The choroid coat exists in all animals yet examined. It is always very vascular. The inner layer, which has been distinguished by the name of *tunica Ruyschiana*, can scarcely be said to exist in man, small quadrupeds, and birds. In the large quadrupeds, however, especially the CETACEOUS animals, it appears in the form of a distinct simple membrane like *epidermis*. The lateral and anterior parts of the membrane are always invested by a semifluid, viscid substance, of different shades of black or brown black (*pigmentum nigrum*); chocolate brown in the hare, rabbit, and pig; deep red brown in some birds; and purple red in the *calmar*. The absence of this dark-coloured pigment, which is not unfrequent, is observed in *albinos*, both human and animal, for instance white rabbits and white mice. The transparency of the Ruyschian membrane then shows the choroid of its natural red colour; and the pupil is red and contracted, and the eye intolerant of light.

The tapetum or metalline membrane.

In the ZOOPHAGA, RUMINANTIA, PACHYDERMATA, SOLIDUNGULA, and CETACEA, the concave or inner surface of the Ruyschian membrane is diversified with colours of metallic lustre, more or less brilliant and something iridescent. In the ox it is of bright metallic green, changing to sky-blue; in the horse, buck, buffalo, and stag, it is a silvery blue passing to violet; in the sheep of a pale golden green, sometimes bluish; in the lion, cat, bear, and dolphin, of a pale gold yellow; and in the dog, wolf, and badger, of a pure white, surrounded by blue. This coloured part of the inner choroid surface, which occupies chiefly the side opposite to that on which the optic nerve enters, is named the *tapetum*. The use of it is by no means obvious. The explanation of Monro in reference to the *tapetum* of the ox, that it represents more distinctly to that animal the colour of his natural food, is not only frivolous, but inapplicable to the other *genera*.

The *tapetum* is wanting in all BIRDS and FISHES, excepting the ray, in which there is at the bottom of the eye a beautiful silvery-coloured space, produced by the transparency of the Ruyschian tunic, through which the tint of the choroid is seen.

The choroid gland of fishes.

In FISHES generally the choroid consists of two distinct separable membranes; the external, the proper choroid, white, silvery, or golden, very thin and not vascular; and the inner or Ruyschian, black, and consisting of a network of vessels. Between these two membranes is a body of a bright red colour, consisting of numerous tortuous vessels, convoluted and inclosed in pulpy filamentous tissue. Its general shape is that of a thin cylinder, encompassing the optic nerve like a ring, which, however, is incomplete at one side. This is the choroid gland,—a body about which there has been some difference of opinion, but which appears to be glandular rather than any thing else. Its vascular structure is well seen in the globe-fish, *perca labrax*, and cod, in which they are very large, and form numerous anastomotic communications. They are generally covered by a white, opaque, viscid fluid.

The choroid gland is wanting in the CARTILAGINOUS FISHES, the eye of which approaches more nearly to that of the MAMMALIA in this as in other circumstances. The choroid of the ray and shark *genera* is a threefold tissue of vessels, thick and consistent; the *tunica Ruyschiana* is very thin and semi-transparent; and between these is a layer of silvery matter with metallic lustre.

In the cuttle-fish genus, though between the sclerotic and choroid there are several glandular bodies, there are none between the choroid and Ruyschian tunic. The choroid is thick, soft, and vascular; the Ruyschian thin, firm, and dry; and though there is no *tapetum*, the whole interior surface of the eye is covered by deep purple, semi-fluid, viscid varnish.

Ciliary processes and circle.

Ciliary processes are found in all the MAMMALIA, BIRDS, several REPTILES, and even in the cuttle-fish among the MOLLUSCA; but they are wanting in almost all fishes.

The indented border of these processes is more distinct, and is converted into a genuine fringe in the large animals, as the ox, horse, rhinoceros, and whale, in which the angle applied to the capsule is more acuminated than in other animals. In the CARNIVORA, particularly the lion, the base of the plates is shorter in proportion to the other sides than in the previously mentioned animals, so that the opposite angle is more prominent; nor is the

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border indented. In all the species every third or fourth plate is shorter than the others, but without determinate order.

The ciliary plates of BIRDS are mere serrated *striæ*, without sufficient prominence to make them undulate in fluid. In the owl they are fine, closely set, and numerous; in the ostrich they are larger and more numerous; and in all, their extremities adhere firmly to the capsule of the lens.

In the tortoise the ciliary processes are so short that they are recognised only by the impression left on the vitreous humour; in the crocodile, however, they are distinct, and terminate each by an angle nearly right. They are indistinct in the toad, and imperceptible in the ordinary lizards and serpents.

The ciliary body and processes are large and distinct in the tope-fish; but if they are seen in any other of the cartilaginous fishes, they are wholly wanting in the osseous, in which the Ruyschian tunic is directly continuous with the *uvea*.

The utility of these processes in retaining the lens in its position is nowhere so distinctly seen as in the eye of the cuttle-fish family, and especially the many-feet of the ancients (*polypus octopoda*). In these the ciliary processes form a large diaphragm or zone, in the aperture of which the crystalline lens is truly chased. They penetrate a deep annular furrow which surrounds the lens, dividing it in two unequal hemispheres, and cannot be detached without laceration.

The iris and uvea.

The *iris*, of the same intimate structure as in man, is of a deep tawny or brown in the MAMMALIA, and marked with fewer coloured *striæ* than the human *iris*. In BIRDS it is of a uniform lustreless colour, varying according to the species, bright yellow, red, or clear blue. In the microscope it appears like a net-work formed by the intersection of numerous very minute fibres. The *uvea* is so fine that when the viscid varnish is removed it becomes transparent, and the iris appears of the same colour on both sides. In FISHES, conversely, the *iris* is so thin and transparent that the *uvea* is seen through it, of a golden or silvery brilliance, showing its direct connection with the choroid. Intermediate in metallic splendour is the iris of the REPTILES. The vessels, however, are greatly more conspicuous, especially in the crocodile.

The central aperture or pupil, though round in man, the QUADRUMANA, many of the CARNIVORA, and BIRDS, is not of that shape when contracted in all animals. In the feline family it consists of two elliptical segments, which form angles above and below, and which approach mutually so as to form a slit nearly vertical. In the RUMINANTS it is oblong transversely, and forms at its greatest contraction an oblong or transverse slit. In the horse, in which it is also transverse, its upper margin is distinguished by a five-pointed festoon. In the whale it is oblong transversely, and in the dolphin it is heart-shaped. The pupil of the crocodile resembles that of the cat; in the frog and gecko it is rhomboidal; and round in the tortoise, chameleon, and common lizards. In the ray among FISHES the upper margin forms several radiating slips like the branches of the palm-tree, gold-coloured without, dark within. In the dilated state these slips are folded backwards between the upper margin of the pupil and the vitreous humour; but when the eye is pressed they are erected, and close the pupil like a blind.

The motion of the pupil is voluntary in the parroquet, and is indistinct in most of the FISHES.

The pupillary membrane is well known to exist in the fœtuses of all the MAMMALIA; but it is not determined whether it is found in the chick of birds.

On the subject of the retina in the lower animals the most important point is the structure of the melanoplectic or pectiniform membrane (*pecten, marsupium nigrum*) of BIRDS. In this class the optic nerve forms not a round disk as in the MAMMALIA, but a narrow white line, the margins and extremity of which are in continuity with the *retina*. Along this line is suspended a plicated or convoluted membrane, very fine and vascular in structure, like the choroid, from which, however, it is quite distinct, and entering a depression of the vitreous humour almost like a wedge. Its vessels, which proceed from a proper branch of the ophthalmic artery, are distributed in a minute arborescent form, among the folds of which the *marsupium* consists; and from these vessels the black viscid pigment with which its folds are covered appears to be secreted. The *plicæ* or membranous folds vary in number. In the cassowary they are only 4; in the brown owl (*S. aluco*) 5; in the common owl, ostrich, Guiana macaw, and merganser, they are 7; in the flamingo 9; in the falcon and swan 11; in the vulture and goose 12; in the duck, large heron, woodcock, and coot, 13; in the stork and partridge 15; in the crane 17; in the pheasant 20; in the turkey 22; in the jackdaw 25; and in the thrush 28. According to the observations of the elder Soemmering, to whom we are indebted for these numbers, the number of folds, though variable in different species, is the same in the same. In most birds the folds are arranged in a pectiniform order. On the use of this organ different opinions have been entertained by Petit, Haller, and Home; but all of them are conjectural.

The melanoplectic membrane, or *marsupium nigrum*, and its folds.

In the REPTILES and many FISHES, between the optic nerve and the *retina* is a small tubercle, from the margins of which the latter membrane appears to rise; and radiating fibres are perceived more distinctly than in most quadrupeds. In many other FISHES the connection of the retina with the optic nerves resembles that of BIRDS. Thus, in the salmon, trout, herring, mackarel, cod, dory, and moon-fish, the optic nerve, after passing through the Ruyschian tunic, appears to be parted into two long white processes, which, following the outline of this membrane parallel but not contiguous to each other, are connected with the *retina* by their opposite margins.

In all animals provided with ciliary processes the *retina* terminates at and is connected with the gray pulpy zone denominated ciliary ligament. In those without ciliary processes, as the FISHES, it terminates suddenly at the attached or large margin of the *uvea*.

In several of the reptiles the retina presents the yellow spot of Soemmering. The principal peculiarities of the humours have been already mentioned.

Of the appendages the most important are the lacrymal gland and nictitating membrane.

Lacrymal gland.

In the Ruminants the lacrymal gland consists of two or three bodies, each composed of granules, each provided with a separate short excretory duct. In the hare and rabbit, in which the gland is large, there appears to be only one excretory duct, which perforates the upper eyelid near its posterior angle.

A gland peculiar to certain species, and wanting in man, that of *Harder*, is situate at the external or nasal angle, and presents an aperture under the third or nictitating eyelid, from which issues a thick viscid fluid. It is found in the RUMINANTS, the RODENTIA, the PACHYDERMATA, and in the sloth genus.

The caruncle exists in the RUMINANTS as in man, and appears to consist of numerous aggregated follicles. It is wanting in the RODENTIA.

In the CETACEA, as in most animals which live under water, there is neither gland nor lacrymal passages; and they are represented apparently by *lacunæ* below the upper eyelid, which discharge a thick mucilaginous fluid.

BIRDS, though destitute of caruncle, have both lacry-

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mal gland and that of Harder, the latter large, oblong, and flesh-coloured, placed betwixt the *levator* and *adductor*, and discharging by a single canal, opening at the inner surface of the third eyelid, a thick yellow fluid. The lacrymal, which is small, round, and very red, is provided in general with two or three canals, which, though small, are distinct. In most of the GRALLÆ and PALMIPED Birds there is, in place of the lacrymal gland, a hard granular body, occupying the upper part of the orbit, and following in situation the curvature of the eye. It has, nevertheless, no visible excretory duct.

Muciparous follicles.

In the turtle there is a reddish granular lobulated body, of considerable size, extending beneath the temporal vault. In the tortoise, frog, and toad, there are two small blackish glands without apparent excretory ducts. Neither in Serpents nor FISHES has any glandular apparatus in the eye been recognised.

The third eyelid or nictitating membrane.

Though in man and the monkey tribe the eyelids consist of two semilunar cutaneo-muscular folds, with a minute mucous duplicature at the nasal angle, the latter acquires such a developement in the lower animals as to constitute a genuine third eyelid, often distinguished by the name of *nictitating membrane*. This duplicature is semilunar in shape in the Ruminants, EDENTATA, and PACHYDERMATA. In the rhinoceros it is thick and fleshy; but of this the CETACEA present no trace. In the BIRDS, on the contrary, in which the eye is covered by the elevation of the lower eyelid, which is also the largest, the third eyelid is large, and covers the eye like a blind drawn before it; yet it is in some degree translucent, for it is evident that birds see objects through the membrane. In the owl and goatsucker the eye is closed by the depression of the upper as well as the elevation of the lower eyelid.

Though the SERPENTINE reptiles are void of eyelids entirely, in the crocodile, tortoise, and BATRACHOID, there are three, as in birds, the third being vertical in the two former orders, and horizontal in the latter. In the SAURIAL and CHELONIAD, also, the third, which is translucent, moves from before backwards by means of a single muscle, and may cover the whole eye. In the lizard *genus* the eyelids consist of a circular veil drawn before the orbit, and perforated by a horizontal fissure, which is shut by a *sphincter*, and opened by a *levator* and *depressor*. The gecko has no movable eyelid.

Compound eyes of the ARTICULATA.

In insects, the eye consists of innumerable hexagonal surfaces, slightly convex, and mutually separated by minute furrows, containing fine hairs variable in length. Each of these hexagonal surfaces, which constitute a hard, elastic, very transparent membrane, may be regarded as a cornea or crystalline lens, convex externally, concave within, and thicker in the centre than on the margins. Immediately behind is an opaque, viscid coating, varying in colour in the different species, analogous to the choroid pigment of the vertebrated animals, and completely obstructing the transmission of light. Beneath this varnish are short, whitish filaments, corresponding in number to the corneal surfaces, and mutually joined like mosaic or tessellated pavement, separated only by the dark-coloured pigment, and which appear to correspond to the *retina* of the VERTEBRATA. Behind these again is a delicate, dark-coloured membrane, which appears to correspond to the choroid; and exterior to this is a membrane continuous with the optic nerve, and which seems to be a *general retina*, forming, by subdivision of its parts on the anterior part of the choroid, the *divided* or multiplied *retina*. This is the structure of what are named *compound eyes*. That of the simple eyes of insects is too minute to be accurately demonstrated; but analogy gives probability to the inference that they are not dissimilar.

SECT. III.—THE EAR.

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In warm-blooded animals generally, that is, in the MAMMALIA and BIRDS, the labyrinth or essential part of the organ consists of three semicircular canals, with a globular enlargement to each (*ampulla*), a cavity common to these canals named vestibule (*vestibulum*), and a conical tapering canal, divided into two compartments by a longitudinal *septum*. This may be named the bilocular cone (*conus bilocularis*). These parts consist of membranous substance inclosed in the bony walls of the pyramidal or auditory bone. In all the MAMMALIA the bilocular conical canal is convoluted in a spiral form, and hence is denominated, as in man, the *cochlea*—a name, however, which is applicable to it in this class only.

Cochlea and canals.

The organ of hearing in the MAMMALIA consists of the same parts nearly as in man. In some, indeed, for instance the guinea-pig (*cabiai*), and porcupine, the *cochlea* makes three turns and a half; and, conversely, in the CETACEA only one and a half. In most of the ZOOPHAGA, and in the hog, elephant, and horse, the *cochlea* is much larger in proportion than the semicircular canals; but in the hare it is small, and in the mole very small. In the CETACEA, while the *cochlea* is very large and fully developed, its spiral is on the same plane throughout; and the semicircular canals are so small, that their existence was long denied by Camper, till they were demonstrated by Cuvier in a fœtal whale. In general the labyrinth of the MAMMALIA is greatly smaller in proportion to the head than in BIRDS.

This part, which is membranous, is inclosed in the solid compact substance of the temporal pyramid, so closely that its existence appears to be identified with the latter. Researches, however, on the labyrinth in the fœtus of the MAMMALIA, and especially in those of whales, demonstrate the fact that it is in a completely membranous form, distinct from the bony inclosure; that in shape and constituent parts it exists previous to the bony inclosure; and that the latter is afterwards moulded round the different parts as they acquire their full developement. It is also to be observed, that in the mole the semicircular canals are seen within the cranium without preparation, and the *cochlea* is merely inclosed in fine cellular tissue. In the bat family, also, both parts are seen without bony inclosure.

Tympanum.

The tympanum forms a cylindrical or spheroidal cavity in most of the MAMMALIA. In most of the DIGITATA the mastoid process consists of a slight prominence of the *tympanum* only as it is identified with the latter; but in the *cabiai*, guinea-pig, hog, the Ruminants, and SOLIDUNGULA, it is represented by a long process of the occipital bone. In most of the ZOOPHAGA and RODENTIA the *parietes* of this protuberance, which are thin and hard, form by their separation a large cavity. In the hog only it is occupied by a firm cancellated structure.

Tympanal bones.

All the MAMMALIA, except the *ornithorhyncus*, have the tympanal bones as in man; the hammer (*malleus*), anvil (*incus*), orbicular bone and stirrup (*stapes*). The lenticular bone, which is rarely found in the adult, is probably only an epiphysis of the anvil. They are articulated with each other so as to admit of motion, and are moved by the same muscles as in the human subject—the *internus mallei*, *externus mallei*, *laxator tympani*, and *stapedius*. In the *ornithorhyncus*, however, there are only two tympanal bones.

External aperture.

In all the MAMMALIA, except the Cetaceous, the ear is provided with a bony external canal (*meatus*); and most of the MAMMALIA, except the Cetaceous, have a cartilaginous funnel-shaped opening (*concha*) attached to the outer margin of the bony *meatus*, and which serves to

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collect the sonorous vibrations, and direct them to the *meatus*. The other exceptions are among the INSECTIVORA, the mole, and some of the shrew *genus;* among the RODENTIA, the *zemni* or blind rat, and some of the rat-mole *genus;* among the EDENTATA, the pangolin or scaly ant-eater; and among the AMPHIBIA, the morse and several species of seal; and the *ornithorhyncus paradoxus*.

The *tympanum* of the CETACEA is peculiar. It consists of a bony plate, convoluted on itself like a *buccinum*, unless that the thick side, instead of containing a spiral cavity, is entirely solid. The opposite side is thin, with an irregular margin. The anterior extremity of the *tympanum* is open, and there commences the Eustachian tube, which ascends along the pterygoid process, and, penetrating the maxillary bone, terminates at the upper part of the nose. This direction of the tube and position of its orifice is so much more necessary, because, since these animals have no external bony *meatus*, and the ear-hole scarcely admits a pin, the vibrations of the air reach their organ of hearing entirely by the Eustachian tube, and because the Eustachian tube also in these animals conveys odorous impressions to the part in which the sense of smell appears to reside. The aperture by which it communicates with the nose is provided with a membranous valve, which prevents the water from entering when the animal expels it by his nostrils.

In BIRDS, of the three semicircular canals the vertical is largest, and obliquely directed forwards and outwards; the second is horizontal and turned outwards; and the third, which, like the first, is vertical, crosses the second, and is turned in the direction opposite to that of the first. The vestibule is small and nearly spherical. The bilocular cone, which is obtuse at the *apex*, is situate obliquely backwards and outwards below the inferior part of the cranium. The longitudinal septum consists of two narrow cartilaginous plates connected by a thin membrane. The posterior canal is short, and, as in the MAMMALIA, is separated from the tympanal cavity by the membrane of the *fenestra rotunda;* while the anterior, which is larger, communicates directly with the vestibule. The whole of these parts are inclosed, as in the MAMMALIA, in the compact bone of the pyramid.

Bilocular cone no longer spiral.

The posterior and inferior walls of the tympanal cavity are formed by part of the occipital bone; the lateral aperture is large, and the cavity superficial; and its anterior part is closed by the posterior superior *cornu* of the quadrilateral bone and a membrane. The inner wall presents the two apertures—the oval or vestibular, and the round or cochlear. In this class, however, while the upper is round or triangular, the lower is distinctly elliptical,—a disposition the reverse of what is observed in man. The Eustachian tube or tympano-guttural canal is entirely osseous. The tympanal cavity contains only one *ossiculum*, consisting of two branches; the first attached to the tympanum, corresponding to the *malleus;* the second closing by an oval or triangular plate the vestibular aperture, and therefore corresponding to the *stapes* of the MAMMALIA. By Carus the incus is supposed to be represented by the quadrilateral bone.

Tympanal bones disappearing or modified.

The external *meatus* is short, and opened by a simple aperture, while the absence of external ear is compensated by a ring or zone of fine elastic feathers with thin barbs, between which the air passes very easily. In the owl tribe it terminates in a large cavity, the margins of which are covered by a smooth valvular fold of skin.

Bilocular cone disappears.

The ear of the REPTILES is remarkable for the last appearance of the bilocular cone, and the first of the saccular apparatus which is found in the Fishes. In the crocodile and lizard this part appears, as in Birds, in the shape of a conical tube, divided by a cartilaginous partition into a double canal, one separated by the membrane of the round hole from the tympanal cavity, the other communicating with a membranous sac containing three very small friable stones, not harder than starch. There are also three semicircular canals of considerable size, each forming a large circumference. In the frog and toad, while the three canals form almost a complete circle, the sac contains an amylaceous friable stone; but the bilocular cone is no longer observed. In the salamander, also, in which the three canals form together a sort of equilateral triangle, the sac which is below contains a single amylaceous stone. The same arrangement is observed in the Cartilaginous Fishes, unless that the sac contains two amylaceous stones, nearly oval in shape, suspended in a gelatinous semifluid pulp. In the Osseous Fishes it is a little different. The three semicircular canals terminate in a membranous sac, which is divided by septa into compartments which contain one, two, or three small stones suspended in gelatinous fluid. These minute stones, however, instead of being soft, friable, and amylaceous, as in Reptiles and cartilaginous Fishes, are as hard as rock, and white as porcelain. These parts are situate on the sides of the cranial cavity, and are fixed to it by cellular tissue, vessels, and osseous or cartilaginous processes. This sac, in the fluid of which the extremities of the auditory nerve are distributed, is believed to correspond to the bilocular cone of the higher classes.

Lithophorous sacs and amylaceous stones appear.

These membranous cavities are contained, in the bony fishes, in the general cavity of the cranium; and while only the middle of the canals is inclosed in the bone of the cranium, the extremities and the sac are quite free. The sturgeon, which belongs to the cartilaginous order, is the first in which the canals are entirely inclosed in the cranial cartilage; but even in this a membrane is interposed between the cranium and sac, which is free. In the ray and shark *genera*, again, these organs are entirely inclosed in the cartilage of the head.

The tympanal cavity, in like manner, is modified, and eventually disappears as we descend in the scale. Though present in the tortoise, crocodile, and lizard tribe, it is superficial and open; it becomes membranous behind in the RANINE tribe, and communicates directly with the back of the mouth; and in the SERPENTINE reptiles it entirely disappears, so that the handle of the osseous plate by which the oval aperture is closed is suspended in the soft parts with its free extremity below the skin, near the articulation of the lower jaw. In the lizard tribe, also, the round or cochlear aperture is seen for the last time. In the Cheloniad, for instance, the Batrachoid, and the Serpentine, this aperture disappears, and the oval or vestibular alone is left; and in the salamander both disappear, and there is no communication between the external part of the cranium and the labyrinth. This arrangement is continued in the fishes.

Cochlear aperture disappears.

Vestibular aperture disappears.

In the molluscous animals the labyrinthine membrane is a simple sac, globular or ovoidal, containing pulpy matter, in which is suspended a small body, which is osseous in the *sepia* and amylaceous in the many-feet (*polypus*), in which the filaments of the auditory nerve are distributed.

Our limits do not allow us to enter into the detailed description of the organ in the other INVERTEBRATED animals.

SECT. IV.—THE ORGAN OF TASTE.

Though the sense of taste is seated chiefly in the tongue in animals, yet that organ performs, in all the classes, so important a part as an instrument of prehension, that it cannot with much justice be distinguished by the former title only. In the present section, therefore, we must regard it as one of prehension as well as of taste.

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The tongue.

In the MAMMALIA and BIRDS the tongue is a muscular organ invested by mucous papillated membrane, supported by a proper bone, the hyoid, which serves as a point of support in its various motions. In the RANINE REPTILES it is also muscular, attached to the margin of the lower jaw. In the salamander, however, it is attached as far as the tip, and is movable on the sides only. In the crocodile it is attached so generally, both by tip and margins, that it was long asserted that the animal was tongueless. In the *stellio* and *iguana* it is as movable as in the MAMMALIA; and in the scinc and gecko to this property is added that of being bifid, or divided by a longitudinal notch into two pointed tips. In the ordinary lizard, tupinambis, monitor, &c. the tongue is remarkable for its great extensibility, and terminates in two long, flexible though semi-cartilaginous extremities. That of the chameleon is still more extensible, and forms, by a peculiar arrangement of vessels, a cup-like extremity. The tongue of the blind worm (*anguis fragilis*) and *amphisbœna* is also bifid at the tip. The cartilaginous fishes are void of tongue, while in the bony division of the class this organ is represented by a hard protuberance, attached to the middle branchial bone.

In some of the MAMMALIA, however, the tongue is not exclusively muscular. In the singularly long, extensible, and tortuous tongue of the giraffe, Sir Everard Home describes a peculiar arrangement of vessels, which he represents as a substitute for muscular motion. Though Sir Everard does not appear to understand the exact nature of this arrangement of vessels, all the circumstances tend to show that it is that denominated erectile. These vessels, from the account given, are large, numerous, and communicate freely; and it would be impossible to discover the reason of such a vascular system, unless for some purpose of this description. (*Phil. Trans.* Comp. Anat.) When the tongue is protruded it becomes perfectly black or bluish-black, evidently from the injection and detention of the blood in its elongated and anastomosing veins. By means of this mechanism the giraffe not only elongates the tongue to the distance of about twenty inches or two feet beyond the mouth, but twists it round the soft leafy twigs of the trees on which he feeds. It is not improbable that a similar vascular arrangement exists, though in less degree, in the tongue of the deer, and in the long projectile tongue of the animals of the ant-eater tribe, as the *Tamanoir*, *Tamandua*, &c.

Erectile arrangement in the tongue of the giraffe,

and of the chameleon.

The erectile arrangement is still more distinctly presented in the tongue of the chameleon. The researches of Mr Houston of Dublin show that the tongue of this animal consists of two parts,—a prehensile, which is anterior, and provided with a glandular apparatus for secreting the viscid fluid by which its tip is covered, and insects are entangled; and an erectile, which is posterior between the prehensile and the hyoid bone, in the form of a trellis-work of innumerable minute anastomosing blood-vessels, not very dissimilar to those of the cavernous body in animals generally, and inclosing a central tube connecting the prehensile portion to the hyoid bone. The effect of this arrangement is, that when the vascular network is injected with blood, the anterior part of the tongue is rapidly darted out at the insects on which the animal lives. The injection of these vessels, and the consequent projection of the tongue, is not independent altogether of the will of the animal; for the veins by which the blood is returned pass through a slit in the tendon of the internal cerato-maxillary muscles, which are always contracted in order to protrude the hyoid style, and thereby tend, by compressing the veins, to inject the erectile part, and project the tongue. (*Trans. R. I. Acad.* 1828, and *Dublin Hospital Reports*, vol. v. p. 487.) The same arrangement is in all probability found in several of the lizards, the tongues of which, like that of the chameleon, are darted out suddenly, and become of a dark-blue colour at the moment of projection.

Papillæ

In all the MAMMALIA the tongue is invested by a papillated muco-villous membrane, in which the papillæ are of the same general characters as in man—granular, mushroom-like, or fungiform, tubercular or calycoid, and conical or acuminated. The only differences consist in the size and abundance of the fungiform *papillæ*, in the number of the calycoid and the mode of their arrangement, and in the shape of the conical papillæ and the mode of their termination. In the Ruminants especially, the conical papillæ are numerous, long, slightly incurvated, and each terminating in a horny but flexible style slightly incurvated backwards. The tongue of the dolphin and porpoise, examined even by the microscope, presents no distinct conical papillæ, but is covered by minute eminences, each penetrated by a small aperture.

Worm of the dog; its absurdity.

In the tongue of the dog *genus* there is a ligamentous substance extended longitudinally from the hyoid bone to the tip of the member. This, which has been vulgarly distinguished by the name of *worm* of the tongue, and has been absurdly supposed to be the seat of hydrophobic *rabies*, is merely a central pillar of support for the muscular fibres to act with greater steadiness and effect, and which enables the animal to protrude and expand the tongue in lapping water or other fluids better than he could have otherwise done. A similar central ligament is found in the opossum.

The tongue of BIRDS is generally more or less horny, and almost cartilaginous. That of the woodpecker and wryneck is peculiar in consisting of two parts,—a basilar or posterior, loose and fleshy; and an anterior projectile, long, smooth, acuminated, and covered laterally with four or five stiff spines directed backwards, which make the organ a sort of barbed arrow. The soft, loose, or basilar part of the tongue contains the aperture of the glottis; and the surface is covered with minute spines pointed backwards, and each of which is placed in the centre of a fleshy *papilla*.

Trunk of the elephant.

As a prehensile organ of very singular construction, the trunk of the elephant deserves particular notice; and it cannot be more conveniently introduced than under the present section, since it is used not only to convey food, but drink, into the mouth. The trunk may be described as a cylindrical tubular organ, consisting of integument, a sort of fibro-cartilage, muscles, fat, and a membrane of villous character internally. This tube contains two long canals continued from the nostrils, parallel to the axis of the trunk, and separated throughout by a partition of adipose substance about two fifths of an inch thick. From the extremity to the middle part of the intermaxillary bone, in which the tusks are fixed, these canals are nearer the anterior-superior than the posterior-inferior part of the tube, the latter wall being thickest; and their diameter is the same throughout. At this part they undergo a sudden incurvation, approaching the anterior surface of the intermaxillary bone, and form a semicircular bend with the convexity turned forwards. Here also they are so narrow that, without a muscular effort on the part of the animal to dilate them, fluids could not ascend beyond this point; and hence this forms the only valvular contrivance, either to impede the progress of fluids upwards, or to propel them downwards, at the will of the animal.

Above this curvature each canal is dilated before the upper part of the intermaxillary bone, and again is contracted where it bends back to enter the bony nostril; and the curvature is protected before by the nasal cartilage, which is oval, convex in the male, and flat in the female.

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Both canals are lined by a dry, greenish-yellow coloured membrane, marked with superficial intersections (*rugæ*), inclosing rhomboidal spaces, and some venous branches.

Muscular apparatus of the trunk highly complicated.

Though the muscular *fasciculi* of the trunk are numerous, they may be referred to two orders,—those forming the substance or inner part of the organ, and those by which it is invested. The former, which are transverse, and cut the *axis* in different directions, consist of numerous small muscular packets proceeding in various directions, some running from the inner membrane to the circumference of the tube, others directly from right to left, and others crossing the two former obliquely. All these little muscles are inclosed in cellular tissue, containing white homogeneous fat; and all of them terminate in slender tendons, some of which cross the layers of the longitudinal muscles in their course to the external covering, while others are attached to the internal membrane. Cuvier calculates the number of these minute transverse muscles in the trunk of the elephant to be not fewer than 30,000 or 40,000. (Plate XXXVII. fig. 13.)

The longitudinal muscles, which are external, may be distinguished into anterior, posterior, and lateral bundles. The first extend from the anterior surface of the frontal bone, above the nasal bones and cartilages, in parallel bundles, connected by tendinous intersections downwards on the trunk. The posterior extend from the posterior surface and inferior margin of the intermaxillary bones, and form two layers which meet on the median line along the lower surface of the trunk. The lateral muscles form two pairs, one of which, descending between the anterior and posterior muscles to the middle of the trunk, may be regarded as a continuation of the orbicular muscle of the lips, or the representative of the *nasalis labii superioris;* while the other, which is attached to the anterior margin of the orbit, and is expanded over the root of the former, may be supposed to correspond to the *levator* of the upper lip.

The whole of these muscles are supplied by a very large branch of the infraorbital or second branch of the trifacial nerve, which, entering on each side between the lateral and superior muscle, is distributed to the whole of the trunk.

With such a construction, it is not difficult to understand the numerous motions of the elephant's trunk. While the longitudinal muscles are employed either to shorten the tube, to bend it upwards or downwards or to the side, or by means of the tendinous intersections to give it peculiar inflections, it is manifest that the transverse ones, which act as antagonists to the longitudinal, may also either dilate or close the canals, or incurvate or alter the direction of particular parts.

Vacuefying apparatus in the feet of certain animals.

The foot of the *Lacerta Gecko* and the house-fly presents a prehensile apparatus of peculiar construction for walking along surfaces, in opposition to the action of gravity. In the former animal the plantar surface of each toe presents sixteen transverse slits, leading into an equal number of pouches, which by means of appropriate muscles are capable of forming an equal number of *vacua*, so that the atmospheric pressure is employed with muscular effort to support the animal in his unnatural position. A similar apparatus is found in the upper surface of the head of the sucking fish (*echeneis remora*); and something approaching to it, though less distinctly, in the foot of the walrus. (Home, *Phil. Trans.* 1816.)

CHAP. IV.—COMPARATIVE ANATOMY OF THE ORGANS OF VOICE.

Under this head our limits allow us to mention very few circumstances.

In the American long-tailed monkeys (*sapajous*) the cuneiform cartilages form, by means of adipose cellular tissue, before the upper extremity of the ventricle of the *glottis*, a large cushion like a spherical segment, which, touching that of the opposite side, causes the air to whistle through the canal in its course to the mouth, and occasions the flute-like voice of some of these animals, as the weeper (*s. apella*) and the capuchin (*s. capucina*). In the howler (*s. seniculus*), so remarkable for its morning and evening yelling, though the larynx is similar in general characters to that of the common *sapajou*, in having the two rounded cushions before the ventricles, the hyoid bone is arched in the form of a spherical chamber, with a large quadrilateral aperture, and each ventricle opens into a membranous sac, lying between the *epiglottis* and the adjoining wing of the thyroid cartilage. The air, which passes between the vocal chords, is therefore partly impelled into this osseous and elastic cavity of the hyoid bone, and probably by its resonance in this situation gives the voice of these animals the deep-toned howl by which they are known in the American forests.

Voice of the howler ape,

Among the Zoophaga, in the dog the cuneiform cartilages are large, the arytenoid small, the vocal chords well marked, and the ventricles deep. In the feline tribe the anterior ligaments, though destitute of cuneiform cartilages, are thick, and separated from the back of the epiglottis by a broad, deep furrow. The posterior ligaments, though neither free nor sharp-edged, are distinguished from the anterior by an appearance of greater firmness, more regular fibres, and by an intermediate furrow. The approximation of the anterior ligaments towards the *glottis* forms a sonorous vault, in which the air may be forcibly vibrated by the posterior. In the bear the cuneiform cartilages assume the shape of styles, and their posterior extremity forms a distinct eminence, not above, but without the arytenoid cartilages, while the ventricles are merely deep fissures.

The kangaroo has neither cuneiform cartilage, anterior ligament, nor ventricle; and it may even be said to be void of vocal chord, while the margins of the *glottis* are much separated in the middle. This arrangement appears to indicate that the animal is almost destitute of voice. In the opossum, in which there is merely a small inferior ligament susceptible of tension, voice is limited to a whistling sound.

In the Solidungula, in which the cuneiform cartilages are completely concealed by the mucous membrane, there is neither superior ligament nor proper ventricle; but an aperture in the lateral wall of the laryngeal membrane, above the vocal chord, leads into a large, oblong, sinuous cavity, situate between this membrane and the thyroid cartilage, and covered chiefly by the thyro-arytenoid muscles, by which it may be compressed; and above the anterior commissure of the vocal chords, or below the base of the *epiglottis*, is an aperture on the mesial plane, leading into a cavity below the vault formed by the anterior margin of the thyroid cartilage. This cavity, which may be named the infrathyroid, is superficial in the horse, and its aperture is large; while in the ass, with a small, round aperture, the cavity is large, capacious, and globular in every direction, and allows the latter animal to make his voice re-echo in the singularly harsh sound denominated the *bray*. Conversely, though the lateral cavities are equally large in both animals, the apertures in those of the ass are small, round, and situate nearer the *epiglottis* than the vocal chord, while those of the horse are large, oblong, and situate immediately above the vocal chord on each side. On the latter peculiarity appears to depend the neigh of the horse.

of the ass, and horse.

In the Cetacea we recognise neither vocal chords nor *glottis*, that is to say, an aperture variable in size ac-

cording to the will of the animal; but the superior part of the *trachea*, which represents the larynx, forms a hollow pyramid or funnel, rising into the posterior part of the nostrils, in which only it opens, while on the sides is left a passage for the food. This pyramidal funnel is formed by an elongated triangular cartilage, corresponding to the *epiglottis*, attached by membrane to the arytenoid cartilages, which also take the shape of scalene triangles, with the small side connected to the cricoid cartilage. Strictly speaking, therefore, the CETACEA have no larynx, and probably no vocal organ; and the superior part of the *trachea*, with the nostrils, serves merely to admit the atmospheric air for the purposes of respiration.

BIRDS are distinguished by possessing not only a *glottis* or laryngeal aperture similar to that of the MAMMALIA at the upper end of the *trachea*, but a second, denominated the inferior *glottis* or *larynx*, at the lower end, near its bifurcation. The former, which is composed of four cartilages, or six, according as the cricoid consists of one or three pieces, on the middle of the posterior part of which is a small round bone, articulated with two oblong longitudinal bones, parallel, and forming between them in the posterior wall of the windpipe a longitudinal slit, susceptible of approximation by means of muscles, is intended merely to regulate the admission of air into the windpipe, or its expulsion from that tube, and to close more or less accurately its superior orifice.

Inferior or modulating larynx of birds.

The inferior larynx consists of a membrane projecting from each side of the inferior aperture of the *trachea*. This aperture is divided into two, occasionally by an osseous anterior-posterior middle bar, occasionally by the angle at which the two bronchial tubes unite. Since the first bronchial arc has the same curvature as the last tracheal ring, the second and third, which are arcs of larger circles, are less convex without, but more prominent within, than the former. Over this prominence the tracheo-bronchial membrane forms a fold, which, half closing on each side the inferior tracheal aperture, forms a plate susceptible of vibrating by the motion of the air, and producing sound. This apparatus, which constitutes what is named the *inferior larynx*, or rather *glottis*, is of two kinds, one void of proper muscles, the other provided with muscles.

In the former kind of larynx the state of the glottis is altered only by those muscles which depress and elevate the trachea. The depressors are two pairs, the sterno-tracheal and the glosso-tracheal, the latter attached to the bifurcated bone and *trachea*. There are no proper elevators; but the windpipe is raised by the mylo-hyoid muscle through the ligaments which connect the hyoid bone to the superior larynx. In the quiescent or relaxed state, and while the trachea is depressed, the bronchial rings approximate, and the second and third even gliding below the first, the *glottis* may be elongated. When the trachea is elevated by these pairs of muscles, the *bronchi* are at the same time dragged upwards, and the second and third arcs are separated from the first; and while the external prominence of the glottidal membrane diminishes in length, its tension is augmented. These forms of larynx without proper muscles may yet be subdivided into two sorts, as they have or have not lateral pouches, membranous or osseous. These are observed in the male duck (*anas*) and the merganser (*mergus*), but never in the female; and to this perhaps the harsh and deep tone of the voice of the male bird is to be ascribed. The larynx without muscles and without pouch is observed in all the gallinaceous order without exception.

The forms of larynx provided with proper muscles may be distinguished into three subdivisions.

The first, which has only one proper muscle on each side, is observed in the whole of the falcon *genus*, e. g. the eagle, hawk, falcon, buzzard, sparrow-hawk, and goss-hawk; in the owl *genus* and the majority of the waders and swimmers, as the heron, bustard, woodcock, lapwing, rail, coot, gull, cormorant, and some of the passerine birds. In these birds, in which the motions of the lower larynx are necessarily limited, the voice is not variable or extensive in its notes.

The second form of *larynx* has three pair of proper muscles, a *constrictor* of the *glottis*, an auxiliary constrictor, and a *laxator* or opener of the glottis. This kind of larynx is observed in the whole of the parrot *genus* and psittacoid birds generally, as the toucan, macaw, calao, &c.

In the third kind of musculo-membranous *larynx* there are no fewer than five pair of muscles, the longitudinal *levator* of the demiannular cartilages, the posterior *levator* of the same cartilages, the small *levator*, the oblique *levator*, and the transverse *levator*. This quinque-muscular larynx is found not only in all the birds properly named whistlers or warblers, as the nightingale, hedge-sparrow, blackbird, thrush, goldfinch, lark, linnet, canary, chaffinch, &c., but in others whose tones are more monotonous, as the swallow, sparrow, stork, crossbill, &c., and even in some the tones of which are harsh and positively disagreeable, *e. g.* the jay, magpie, crow, raven, &c.

The differences remarked in the notes of these three divisions of birds with the quinque-muscular larynx depend not so much on anatomical peculiarities as on the *timbre* of their larynx, and on the mobility of the *trachea* in relation to the larynx, and on the tracheal membrane having dilatations and contractions.

On the whole, the inferior larynx of birds is to be regarded in three lights: 1*st*, As the reed of a wind-instrument, like a hautboy or clarionet, in which the notes vary as the lower glottis varies in its position to the windpipe; 2*d*, as an instrument susceptible of uttering different tones, according to the distance between the mouth-piece and vent, or as the windpipe is elongated or shortened; and, 3*d*, as an instrument capable of uttering different notes by varying the diameter of the mouth-piece, or as the superior *glottis* is widened or contracted.

The only bird in which the inferior larynx is wanting is the vulture.

The vocal organ of the REPTILES consists of the superior larynx only, analogous to that of the MAMMALIA. This is a cartilaginous apparatus, composed in general of five distinct pieces at least in the large individuals of the SAURIAL *genera*, as the crocodile and alligator, and forming a broad cavity behind, before a narrow slit, bounded by two vertical pillars. The *glottis*, however, is entirely membranous; and there are neither vocal chords nor ventricles. There are nevertheless two muscles, one for opening and another for shutting the *glottis*. When these act, and the air is made to vibrate against the anterior pillars, it gives a slight whistling sound only. In the iguana, tupinambis, lizard, tortoise, and serpent, the arrangement of parts is nearly the same; and these animals, therefore, can utter only slight hissing sounds. In the chameleon the pillars are furnished with a tense, vibrating membrane, a fleshy tubercle which contracts the *glottis*, and a membranous pouch opening below, between the lower laryngeal cartilage and the first tracheal ring. In the frog tribe, so remarkable for their croaking noise, the vocal chords are large and prominent. The males have also two membranous pouches, opening by a small aperture, not in the larynx, but deep in the lateral part of the mouth. When the frog croaks these pouches are inflated, and swell the skin on each side below the ear. Though these sacs are wanting in the female frog, and toad both male and female, as well as the tree-frog, there is beneath the throat a single pouch on the median plane.

CHAP. V.—COMPARATIVE NEUROLOGY.

A general view of the nervous systems in different classes of animals shows that the only common part is an azygous tubercle, situate at the anterior extremity of the spinal chord, connected by means of two lateral bundles or peduncles to the rest of the system. This mass, which corresponds to what is denominated the *cerebellum* in man, is connected in the vertebrated red-blooded animals with several pairs of tubercles, forming generally a larger mass than itself, and connected to the rest of the system by two longitudinal bundles or limbs, which mingle with and intersect those of the cerebellum. These anterior-superior tubercles, which constitute the brain proper, present numerous modifications in figure, disposition, and magnitude, and even in presence, in the different orders of the animal world.

In the vertebrated animals the brain or central part of the nervous system consists of the vertebral or funicular portion, named the *spinal chord*, and the cranial or cephalic portion, properly denominated the brain.

Spinal chord.

The funicular portion has the shape of a *cylinder* flattened on its superior or dorsal and inferior or sternal surfaces. It consists of two similar chordiform productions, united on the mesial plane, and marked at the line of junction by linear longitudinal furrows, of which the superior is most deep and distinct. This, however, which was observed by Blasius in several animals, is denied by Bellingeri, who asserts, from various observations, that though in some parts the superior furrow penetrates more deeply than the inferior, in the general course of the chord the latter is the deepest. (*De Medulla Spinali Annotationes Anatomico-Physiologicæ.* Auctore C. F. Bellingeri, Aug. Taurinorum, 1823.) This discordance appears to depend on the circumstance that the sternal or inferior furrow is in truth deeper and more distinct in man, the monkey tribe, and a few MAMMALIA, than the dorsal; whereas in most others, as the coati, raccoon, horse, &c. the dorsal furrow is of the same depth as the sternal; and in the mole, murine, and leporine *genera*, it is deeper and more distinct than the sternal. In BIRDS and the cartilaginous FISHES the sternal furrow is deepest; in Reptiles the dorsal and sternal are nearly equally deep; and in the osseous FISHES the dorsal is the deepest. On each side of the chord, also, there is a slight longitudinal depression commonly called the lateral (*sulcus lateralis*).

The breadth and thickness of the spinal chord vary in different regions. The lower cervical portion is in general the broadest and thickest; at the upper dorsal region it is somewhat more slender, becoming thicker again at the lower dorsal region; and after again becoming more slender in the lumbar region, it is expanded into a filamentous brush-like termination of different lengths in different classes, and even in different orders. These enlargements at the superior dorsal and lumbar regions are believed by Serres to correspond with the origins of the thoracic and pelvic extremities; and each swelling he represents to predominate over the other, as the animal habitually employs the one or the other kind of members. It is remarkable in illustration of this principle, that in the CETACEA, which are void of pelvic extremities, the lumbar enlargement is wanting; and in the amphibious MAMMALIA, the pelvic extremities of which are feeble, this enlargement is also inconsiderable.

The spinal or funicular brain consists of white cerebral matter on the surface and gray matter in the centre, the former being most abundant, unless in the sacral region, where both are nearly equal in quantity, or the gray rather predominates. In the MAMMALIA the gray matter is in greater proportion to the white than in the other three classes, in which the white matter progressively augments.

The sternal and dorsal longitudinal lines indicate the original formation of the chord in two lateral portions, with an intermediate cavity denominated the spinal canal. This exists only during the formation of the chord in the human fœtus, in some of the MAMMALIA when adult, and in the other three classes. Its disappearance in the human fœtus, and in that of various MAMMALIA, is represented by Serres to depend on the progressive deposition of gray cerebral matter on the inner or central surfaces of the component pillars of the chord. Though obliterated in man, in whom the gray matter is abundant, it is not hermetically sealed in the monkey tribe, in which some traces of it are left. In the AMPHIBIA and CETACEA it is larger than in the monkey tribe; its diameter augments in the CARNIVORA, feline, canine, and ursine, in which the gray matter is thinner than in the former; and in the RODENTIA it is said to be largest of all among the MAMMALIA. Lastly, in the birds, reptiles, and fishes generally, in which the gray matter is scanty and the white predominates, the spinal canal is large and distinct.

The lateral regions of the spinal chord are connected with a double series of nerves by means of two rows of nervous filaments, an anterior and posterior, separated by a longitudinal membrane of fine white tissue, with a serrated or festooned border. This membrane, which is named the denticulate, is the same in the MAMMALIA and BIRDS. That these nerves do not issue from the spinal chord, must be inferred not only from the phenomena attending the original developement of the nervous system, but especially from what is observed of their comparative size, and that of the chord in the inferior classes. In that of fishes especially, while the chord is small and slender, and by no means fills the vertebral canal, it is remarkable that the nerves which supply the voluntary muscles are exceedingly large. Thus, in many both of the cartilaginous and osseous divisions, as the sturgeon, dog-fish, ray, wolf-fish, cod, &c. the nerves which supply the pectoral fins are large, broad chords, two or three of which seem to contain more substance than the whole spinal chord itself.

Bulb of the chord.

The chord is expanded at its cephalic end into a thick eminence denominated the spinal bulb, the surface of which presents three pairs of eminences. These eminences are developed in various degrees in the different classes and orders. In some of the MAMMALIA the anterior pyramids or pyramidal bodies are more distinct than in man, for instance the ape tribe, the CETACEA, CARNIVORA, Ruminants, and RODENTIA. They are small in most Birds, all the Reptiles, and the Cartilaginous FISHES. In the osseous division they assume the appearance of two parallel chords at the base of the brain. The olivary bodies, less prominent in the ape than in man, are still less so in the CETACEA, and progressively through the AMPHIBIA, CARNIVORA, RUMINANTIA, RODENTIA, and INSECTIVORA, and the other three great classes of vertebrated animals. Conversely, the restiform bodies or posterior pyramidal eminences, from man through the ape tribe, the CETACEA, AMPHIBIA, to the Ruminants, CARNIVORA, and RODENTIA, increase in size.

Though the brain of the MAMMALIA presents the same parts, and is arranged nearly in the same order, as that of man, it varies in its proportions to the rest of the body; in its proportions to the *cerebellum* and spinal bulb; in general figure; in the presence, absence, and number of convolutions; in the configuration of its central surface; in the communication of its central with its external surface; and in the manner of its connections with the cerebral nerves. As it is impossible in this sketch to examine all

these circumstances fully, we shall confine our attention to the notice of a few only.

It is not easy to ascertain the proportion of the mass of the brain to that of the rest of the body Excluding as much as possible the ordinary sources of fallacy, in small animals the brain is proportionally larger; yet in this respect man is surpassed only by a small number of animals, habitually lean, and with little muscle, as bats, small birds, &c. While the proportion of brain in man to that of the whole person varies from a 22d to a 35th part, that of the monkey tribe varies from a 22d to a 42d part; and in the baboon it is only the 104th part of the body. Among the MAMMALIA, the RODENTIA have in general the largest proportion of brain, and the PACHYDERMATA the smallest; and while the hare has a brain about the 300th part of the size of the body, that of the elephant, the most sagacious of animals, is about the 500th part the size of his body. It is also remarkable, that while the brain of the horse is only a 400th part of the size of his body, that of the ass amounts to a 254th part. The Reptile brain becomes excessively small, that of the turtle being rather more than the 5000th part the size of his body; and in some of the Fishes, not all, it appears to attain the maximum of decreasing proportion, that of the tunny being so small as the 37,000th part of his body, while the brain of the carp is so large as to approach the proportion of the elephant. It may be doubted whether, under such circumstances, any precise conclusions can be drawn from results so variable and so little to be expected.

The proportional weight of the brain to that of the *cerebellum* is, excepting in the case of one species of ape, the *saimiri*, greater in man than in any other animal. The ox is equal to man in this respect, and the dog approaches him. The animals most remote are the RODENTIA, as the beaver, rat, and mouse, &c.

The convolutions, which are so numerous and so deep in man, diminish both in number and size in the QUADRUMANA and CARNIVORA, and are nearly obliterated in the RODENTIA. In the UNGULATED animals, however, and especially in the Ruminants and the horse, the convolutions are numerous; and even in the dolphin among the CETACEA, they are numerous and deep. In all the MAMMALIA the *cerebellum* is foliated.

On the whole, the peculiar character of the brain of man and the ape family consists in the existence of the posterior lobe and digital cavity. The brain of the ZOOPHAGA is remarkable for the small size of the *nates* or anterior pair of the bigeminous eminences in proportion to the *testes* or posterior pair. In the RODENTIA the organ is distinguished for the large size of the *nates*, and the want or superficial nature of the convolutions. In the UNGULATED division of animals, *i. e.* PACHYDERMATA, RUMINANTIA, and SOLIDUNGULA, the brain is remarkable for the large size of the *nates* combined with the number and depth of the convolutions; while that of the CETACEA is remarkable for its height and breadth, and the want of olfactory nerves. It is further to be observed as a general distinction between herbivorous and carnivorous or zoophagous animals, that in the former the *nates* are larger than the *testes*, whereas in the latter the *testes* are largest. Lastly, Man and the QUADRUMANA are the only animals which possess genuine olfactory nerves. In the other quadrupeds they are represented by the mammillary processes of the ancients; and in the CETACEA they have not yet been unequivocally demonstrated.

The brain of BIRDS is at once recognised by consisting of six distinct tubercles, two representing the cerebral hemispheres, two representing the optic eminences, one the cerebellum, and one the bulb of the chord. The hemispheres are void of convolutions, but the cerebellum is marked by transverse parallel striæ corresponding to the *laminæ* of the mammiferous brain. There is neither middle band (*corpus callosum*), vault, nor *septum*. The ceiling or vault of the aqueduct or passage from the third to the fourth ventricle is not, as in the MAMMALIA, surmounted by the bigeminous eminences, but is merely a thin plate corresponding to the valve. Each optic eminence contains a cavity communicating with the others by the Sylvian aqueduct. The anterior eminences (*corpora striata*) are not striated with alternate white and gray matter, as in the MAMMALIA. Between the anterior and the optic eminences are four rounded tubercles, best seen in the ostrich, which are to be regarded as entirely heterologous to the structure of the mammiferous brain, and connecting the cerebral structure of BIRDS with that of Reptiles and Fishes, in which also these tubercles are observed.

The Reptile brain is smooth and unconvoluted. The optic eminences, which are situate behind the hemispheres, are uncovered, and contain a ventricle communicating with the third. At the extremities of the latter are the anterior and posterior commissures, but there is neither soft commissure nor bigeminous eminences. The hemisphere presents an anterior eminence, which, however, in the brain of Birds is unstriated. The cerebral valve is, like that of BIRDS, unsurmounted by bigeminous eminences.

In the class of FISHES the structure becomes still more simple. The tubercles of which the brain consists are placed in a row; and their increase in number only demonstrates the decomposition of the organ, and its resolution into simple integrant parts. The two representing the hemispheres are ovoidal, unconvoluted, and contain a ventricle, in which is seen the eminence analogous to the striated bodies. The optic eminences, situate beneath the hemispheres, though small, contain each a cavity, as in the two oviparous classes already noticed. Lastly, there are in several *genera*, under the common vault of the hemispheres, occasionally two, occasionally four tubercles, variable in shape and proportions, but which would be analogous to the bigeminous eminences, were they not, like those already mentioned in BIRDS, situate before and above the optic chambers. In the cartilaginous fishes, in which these tubercles are not observed, the anterior or striated eminences are obliterated. The *cerebellum* does not cover the fourth ventricle.

Behind the *cerebellum* are two tubercles, which in the ray give origin to the fifth pair, and are very distinct in the pike, trout, salmon, and perch. These tubercles are peculiar to this class.

The cavities in the interior of the optic eminences in Birds, Reptiles, and Fishes, are observed in the fœtal brain of the MAMMALIA during its early growth.

It is almost superfluous to mention, that, in the two warm-blooded classes, Mammalia and Birds, the brain, with its investments, fills completely the cranial and vertebral cavities. In the Reptiles, however, in which the brain does not approach the cranial walls, we remark the first departure from this arrangement; and in the Fishes it is so completely violated that the brain and chord occupy but a small proportion of the cranio-vertebral cavity; and between the former and the osseous walls there is a quantity of fine but very loose filamentous tissue, containing in its cells a large quantity of pellucid fluid. Though this arrangement gives this the appearance of a white jelly-like substance, it is not gelatinous, as is generally represented, but merely a pellucid fluid, sometimes pale straw-coloured, occasionally with a reddish tint, contained in numerous communicating cavities of a tissue which appears to represent the arachnoid of the warm-blooded animals.

Comparative Anatomy.

The *pia mater* in the reptiles and fishes is reduced to a filamento-vascular web, accompanying the blood-vessels.

The *dura mater* undergoes some peculiar modifications in different orders. In the duckbill a bony plate is contained between the *laminæ* of the falx; and the same structure is found in the porpoise, perhaps in the other CETACEA. An osseous *tentorium* with a quadrangular aperture is found in the coaïta and marten, and the feline and ursine families; and an osseous partition consisting of three parts is found in the dog, horse, Cape ant-eater (*orycteropus*), the wombat, and the seal. The bony *tentorium* is also found in the woodcock and others of the feathered class. In the red but cold-blooded animals the *dura mater* forms neither falciform nor tentorial process.

On the nerves or ramified chords of the nervous system a few words must suffice. In fishes the tenth or pneumogastric consists not of a common trunk, but of three orders of filaments, the first and largest of which are distributed to the gills, and correspond to the pulmonary nerves of the MAMMALIA; the second, slender, are distributed to the muscles of the tongue and the surface of the *œsophagus;* and the third terminate in a large nerve which traverses the body longitudinally immediately beneath the lateral line. The phrenic nerve is wanting in birds, reptiles, and fishes.

In the MOLLUSCA the nervous system consists of a number of whitish cerebral masses distributed in different parts of the body, with one or two more conspicuous than the rest, and supposed therefore to represent the brain, placed transversely over the œsophagus, which it encompasses with a nervous collar.

In the ARTICULATA the nervous system consists of two long chords extending along the belly, and expanded at various intervals into gangliform knots or enlargements. The first of these, which is situate on the œsophagus, rarely exceeds the others in size. Among the ZOOPHYTES hitherto examined the nervous system assumes either a radiated or an arborescent form.

PART II.

COMPARATIVE ANATOMY OF THE ENTROPHIC ORGANS.

CHAP. I. THE LIMITROPHIC ORGANS.—SECT. I. THE ORGANS OF DIGESTION.—§ 1. THE TEETH.

Though genuine teeth are found in three classes of animals only, viz. the MAMMALIA, the REPTILES, and the FISHES, yet all the orders of these classes are not provided with teeth. Thus, among the first class, the ant-eater tribe, the pangolin, the *echidna* and *ornithorhyncus*, and the whales—among the second the *cheloniads*—and among the third the sturgeon—are altogether destitute of these organs. In all the invertebrated classes, the jaws, when present, are provided with notches varying in number. The *echinodermata* alone have genuine teeth, inserted in a mechanical apparatus very different from ordinary jaws.

Though in general structure the teeth of the lower animals resemble those of man, in some respects they differ considerably. These varieties consist either in some change or modification of the constituent parts of the teeth, or in the addition of some other substance to those parts.

The first variety to be noticed is of the former description.

Bone of tooth.

Though in the QUADRUMANA and ZOOPHAGA the bony matter of the teeth is quite similar to that of man, in other orders this substance appears in the form of a very hard, compact, and more regularly fibrous substance than bone, and to which the name of ivory (*ebur*) is applied. It is chiefly in the canine or tearing teeth that this substance is found to represent the bony pillar of the teeth; and it is principally among the PACHYDERMATA, and some of the AMPHIBIA and CETACEA, that this change is observed.

Ivory of different animals.

The ivory of the elephant is the most tender, and that which most rapidly becomes yellow on exposure to air. It is readily distinguished from the ivory of other animals by the curve lines which radiate from the centre to the circumference of the tooth in various directions, and which form by intersection regular curvilinear lozenges.

The ivory of the hippopotamus is greatly harder and whiter, and is on that account preferably employed for the preparation of artificial teeth. A transverse section of this substance shows *striæ* extremely delicate and regular. In this animal, also, not only the canine but the incisor teeth consist of this substance. The tusks of the Ethiopian boar (*sus Æthiopicus*) consist of ivory similar to that of the hippopotamus. In those of the ordinary boar, though no *striæ* are recognised, there is sometimes a mixture of brown substance disposed in layers. The ivory of the teeth of the morse, though void of *striæ*, is compact and susceptible of polish nearly as brilliant as that of the hippopotamus; and its character is, that the central pillar of the tooth consists of minute round grains, indiscriminately aggregated, like pebbles in puddingstone. The axis or pillar of the molar teeth of this animal, which are without internal cavity, consists of similar minute grains. The ivory of the dugong is homogeneous and without *striæ*. That of the teeth of the white whale or cachalot resembles the bone of human teeth in its satin-like appearance. The ivory of the tusk of the narwal is very compact and homogeneous in appearance.

The most singular structure of teeth among quadrupeds is observed in those of the Cape ant-eater (*orycteropus*). The teeth of this animal, which have the appearance of two cylinders conjoined, consist of an infinite number of minute straight parallel tubes, so that their transverse section resembles that of a rush. As these tubes are closed only at the triturating surface, it is there only that the tissue of the tooth is compact; and when the enamel is worn, the upper orifices of these tubes begin to be exposed. There is, therefore, no general cavity in the interior of the tooth. These teeth are also void of root. A similar tubular structure is observed in the two molar teeth of the *ornithorhyncus*, and in the teeth of some fishes.

Enamel.

The enamel (*lamella vitrea, cortex striatus*) presents peculiarities in the lower animals, as well as the bone of the tooth.

While the enamel of the human tooth is confined to the crown, in several of the lower animals, as the morse, it envelopes the tooth all round; and in the molar teeth of this animal, which, indeed, are void of cavity, it is thicker under the root than at the crown. A similar arrangement is observed in the old or adult teeth of the cachalot, which, when their cavity is obliterated by the full deposition of osseous substance, are also covered with enamel below.

The texture or constitution of the enamel is best seen in the grinders of the elephant. The section of a tooth in the germ exhibits fibres similar to those of asbestos or fine velvet. The fracture of the enamel is more distinctly fibrous than that of the bone, and the fibres are everywhere perpendicular, or nearly so, to the surface of

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the tooth. The hardness of this substance may be inferred from the fact that it strikes fire with steel. These component fibres, however, are not always rectilineal. Most frequently they describe curves with the convexity of incurvation towards the crown and the concavity towards the root. This arrangement at least is observed in the ruminants. The distinction between the enamel and bony matter is recognised by a gray line, and another whiter which belongs to the latter substance.

The enamel varies chiefly in thickness in different animals. The tusks which project from the mouth are generally observed to be less white, less hard, and more similar to bone or ivory than the other teeth; and on this account, probably, the existence of enamel has been denied in the tusks of the elephant. It is nevertheless certain that the external layer of these tusks presents radiating fibres, though it is by no means so hard, or possesses the same grain, as the enamel of the other teeth. Enamel is more apparent, though thinner, in the tusks of the morse, dugong, and boar; and it is quite as distinct in those of the hippopotamus as in the other teeth of that animal. Lastly, the enamel of the teeth of the cachalot, which is very thick, shows in its section only *striæ* parallel to the surface of the osseous substance.

Teeth may be distinguished according to the mode in which their component tissues are arranged into three sorts. 1*st*, When the enamel invests the axis all round, and does not penetrate the latter, the tooth is said to be *simple* (*dens simplex*). Such is the character of the human teeth, and those of the QUADRUMANA and ZOOPHAGA, and several other animals, and all the reptiles.

Simple teeth.

2*d*, When the enamel is folded as it were round the bony part, but without inclosing it, so that the latter forms a continuous band several times folded on itself, and sections of the tooth in every direction divide repeatedly the component substances, the tooth is said to be compound or complex (*dens multiplex vel compositus*). A good example of this structure is seen in the grinders of the elephant.

Compound teeth.

3*d*, When the base or root of the tooth is simple, and the folds of the enamel and bone penetrate only to a certain depth, they are said to be semicompound. Examples of this modification of arrangement are seen in the grinders of the ruminating animals.

Semicompound teeth.

In the compound, and part of the semicompound teeth, the enamel is covered by a third substance; and as the latter is arranged, especially in the former sort, so as to leave intervals between it and the next layer of enamel, this substance serves to fill all these intervals, and consolidates the component lobes of the tooth even before their osseous parts are united below. This substance, which is denominated by Cuvier *cement*, by Tenon *cortex osseus*, and by Blake *crusta petrosa*, though less firm than either bone or enamel, is dissolved by acids more slowly than the former, and sooner becomes black in the fire. In the teeth of the elephant and *cabiai* it forms half their mass at least. In most *genera* it presents no apparent organization, and resembles a sort of crystalline tartar incrusted on the tooth. In the cabiai, however, it presents numerous pores very regularly arranged. Tenon was of opinion that it arose from ossification of the membrane which enveloped the tooth; blake ascribed it to deposition from the opposite surface of the enamel membrane; but Cuvier ascertained that it is deposited by the same membrane and the same surface as the enamel. This accurate observer found, on inspecting the germs of the teeth of the elephant, that when the internal membrane of the dental capsule has deposited the enamel, it undergoes a change of structure, and becomes thick, spongy, opaque, and reddish, to furnish the cement, which is then deposited, not in regular crystalline fibres, but in random drops.

The cement or *crusta petrosa*.

The teeth of the Reptiles consist of hard, compact, osseous matter, invested by a thin covering of enamel, and without cement.

Teeth of fishes.

The teeth of Fishes vary much in structure. They are either simple or compound. The simple teeth are those which consist of bone invested by enamel. They may be distinguished into two species, according to their mode of attachment. The first are the simple teeth, which are not implanted in *alveoli*, but merely attached to the gum, or fixed by articulation to the jaw, as those of the shark tribe; the second are simple teeth growing in alveolar cavities, as is observed in the majority of fishes, the pike, dory, &c. The simple teeth attached to the gum are chiefly distinguished by their fibres intersecting in the manner of the cancellated tissue of bones, and being therefore at first light, porous, and spongy, and becoming afterwards uniformly hard and compact like ivory.

The compound teeth, which consist of an infinite number of minute tubes mutually aggregated and invested by a common covering of enamel, form plates of different sizes, adhering to the bones of the jaws or palate by an intermediate membrane only. In some they affect the disposition of the quincunx; in others they occupy the whole breadth of the upper jaw at least, as in the ray as seen on the small scale, and in the same manner in larger fishes; others are in straight transverse bars; others assume the shape of a circular segment, or the figure in heraldry denominated the chevron.

In the wolf-fish the jaws are provided with eminences composed of fibres or tubes proceeding from the base to the circumference, and which are connected to the jaw by a substance more spongy than the rest of the bone.

Mechanical detrition of the teeth.

After their first formation the teeth retain nearly their original shape in the ZOOPHAGA, man, and the QUADRUMANA. In the two latter only their crowns begin to be worn, rendering the incisor and canine less pointed by the use of food partly vegetable; but in the zoophagous tribes they undergo no detrition whatever. In the herbivorous animals, however, the crown begins to undergo detrition more or less rapidly; and in no long time the superior layer of enamel is entirely worn off, and the surface of the tooth exposes the succession of bone or ivory, enamel, and cement. These substances are well seen in the teeth of the RODENTIA, for instance the hare; those of the PACHYDERMATA, as the elephant; the Ruminants, as the stag, sheep, and ox; and the SOLIDUNGULA, as the horse. In all these animals the enamel, which is hardest, forms prominent lines or ridges; while the bone and cement are indicated by depressions.

This detrition, which is purely mechanical, might proceed to such an extent in the herbivorous quadrupeds as to destroy the whole of the crown of the tooth, and leave the process of mastication to be performed by the jaws only. It appears to be chiefly to obviate this inconvenience that the dentition of the elephant, the Ethiopian boar, and perhaps all the PACHYDERMATA, is conducted in a successive manner through a series of six or eight sets of teeth at least. In the former animal, in which this process has been best observed, and was ably explained many years ago by Mr John Corse Scott (*Phil. Trans.* 1799), each half-jaw, whatever it contains, exhibits at one time only one complete grinder and part of another behind it, the prominent parts of which are placed obliquely to the horizon, forming an inclined plane, so that the anterior parts are worn before the posterior. The anterior complete one, which is employed in mastication, undergoes progressive detrition till its anterior portion is worn down to the level of the jaw. In this state the fangs of the anterior part of the tooth begin to diminish, rendering the tooth narrow before; while the crown of the poste-

Successive dentition of the elephant.

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rior begins to be worn, and undergoing the same detrition, the posterior fangs also begin to give way. While this process, however, is advancing, the posterior tooth, of which only the anterior part was appearing above the gum, gradually rises, with its crown forming a plane inclined from before backwards, similar to that of the anterior grinder. When this posterior tooth has been raised sufficiently to allow its anterior margin to be used in mastication, the residue of the anterior tooth drops out altogether, and the posterior one continues to rise and advance rapidly, until it is completed, when it is found to be much larger than the previous tooth, and to consist of a greater number of plates of ivory and enamel (*denticuli*). In no long time this new tooth, which undergoes the same process of detrition, is succeeded by another one, the anterior margin of which rises first behind the posterior one of its predecessor, and which passes through the same stages of growth, detrition, and shedding. This process is repeated at least seven or eight times, and each succeeding tooth is larger, and contains a greater number of ivory and enamel plates than its predecessor. The elephant has thus 7 or 8 grinders in each half-jaw, or 28 or 32 grinders respectively; yet there are never more than one tooth and part of another, or at most two, that is, eight teeth in the upper and lower jaws, at the same time. Though the disappearance of the fangs of the anterior tooth is ascribed to absorption—which indeed is a good general name—yet the true reason is the fact that the maxillary or dental vessels of the elephant are unable to sustain more than one tooth in each half-jaw at once; and that since these vessels gradually transfer their blood to the new tooth, while those of the old one shrink and are obliterated, as the new tooth grows the old one is actually dehematised or atrophied. The order in which the teeth of the elephant succeed each other is nearly the following. The first or milk grinder, composed of 4 eburneo-vitreous plates (*denticuli*), cuts the gum eight or ten days after birth, is well formed in six weeks, and completely out in three months. The second, which consists of 8 or 9 plates, is completely exposed at the age of two years; the third, consisting of 12 or 13 plates, at six years. The fourth to the eighth grinder consist of plates varying in number from 15 to 23; but the period at which these teeth appear has not yet been determined. This process has been shown to have taken place also in the gigantic fossil animal named the *mastodon*.

A similar process of displacement and renovation takes place in the poison-teeth of serpents, and in the teeth of the shark, *diodon*, and *tetraodon* tribes. In the wolf-fish (*anarrhicas lupus*) the teeth are shed along with the spongy membrane in which they are contained, exactly as the horns of the stag.

Dentition of the horse.

In the horse, in which the process of dentition has been carefully observed, it is usefully employed to determine the age of the animal. The milk incisors appear at the end of 15 days; the four middle ones, or the *nippers*, are shed at 30 months; the four following ones at 42 months; and the four external, or the corner teeth, at 54 months. The permanent corner teeth do not grow so quickly as the other incisors; and by these especially the age of the horse is determined. At first they scarcely rise above the jaw. Their middle then presents a hollow filled with blackish tartar, the margins of which are worn down as the tooth rises from the gum, and is rubbed against the corresponding one; and it diminishes progressively from 54 months to 8 years, when it is altogether obliterated. The hollow of the other incisors is obliterated at a later period than that of the corner ones; and the age of the animal is then estimated from the length of the incisors, which continue to increase.

The first two molar teeth appear in each jaw and on each side about the 8th day, the next at the 20th, and the complementary or small anterior grinder about the 5th or 6th month. The first posterior molar appears about the 11th month, and the second in the 20th. At the 30th or 32d month the first two milk grinders are shed, the third in the 3d year; and about the 5th or 6th year the last posterior grinder appears. The milk grinders are longer from before backwards than the permanent ones, which are themselves contracted in this direction, as they are pressed by the posterior grinders; from which it results that the dental crowns of young horses are oblong, while those of the old are quadrangular.

In the MAMMALIA the teeth are always implanted in the jaw-bones, and never, as in other animals, in the tongue, palate, &c. The only exception to this rule is the *echidna*.

Arrangement of the teeth.

The three kinds of teeth, incisor, tearing, and grinder, are found together only in Man, the QUADRUMANA, the ZOOPHAGA, the PACHYDERMATA except the elephant and two-horned rhinoceros, in the hornless Ruminants, and in the SOLIDUNGULA; but, of all these animals, in man only are the three forms of teeth arranged in an uninterrupted series, and in such a manner that those of the lower jaw are applied to those of the upper. In one other animal only, now extinct, the *anoplotherium*, is this continuity of arrangement observed.

In the QUADRUMANA and ZOOPHAGA, and all those in which the canine are larger than the other teeth, there is a gap on each side of the jaw to receive the canine of the opposite one. In the ursine genus there is a large empty space behind each canine tooth. In the hedgehog, shrew, phalanger, and tarsier, in which the canine are shorter than the other teeth, a space is left between them and those opposite. In the maki tribe, proper bat, colugo, and camel, there is a large interval between the upper incisors. Lastly, the Ruminants want the incisors of the upper jaw, and the morse those of the lower.

Some animals provided with the three classes of teeth lose the incisors at a certain age; for instance several of the bat tribe, and the Ethiopian hog. Other Mammalia have only two sorts of teeth, for instance incisors and grinders, separated by an interval without canine, as the wombat and all the RODENTIA, in which there are only 2 incisors in each jaw; the kangaroo, which has two below and 6 or 8 above; and the cavy or *hyrax* genus, which have 2 above and 4 below. The elephant has grinders and two tusks planted in the superior intermaxillary bone, but no inferior incisors or canine teeth.

Animals may possess grinders and canine teeth without incisors, as the sloth tribe and the dugong. The grinders, which are most essential, are most rarely wanting; and when others are deficient these are present, as in the armadillo tribe, the *orycteropus*, the *ornithorhyncus*, two-horned rhinoceros, and lamantin. The jaws of the dolphin are provided with uniform conical teeth all round, while the cachalot or white whale has them in the lower jaw only. In the narwal there are only two long spiral tusks implanted in the intermaxillary bone, and of these one is often wanting.

Absence of the teeth.

Lastly, teeth are entirely wanting in the ant-eater tribe, pangolin, and *echidna*, which are therefore arranged among the EDENTATA. In the whale the teeth are represented by plates of the laminated, fibrous, bluish substance distinguished by the name of *whale-bone*.

§ 2. ORGANS OF INSALIVATION.

Under this head ought to be noticed the modification which the salivary glands undergo in the lower animals. Our limited space, however, obliges us to proceed immediately to notice the peculiarities of the other divisions of the alimentary canal.

§ 3. Œsophagus, Stomach, and Intestinal Tube.

Œsophagus.

The muscular tissue of the œsophagus consists, in most of the Mammalia, of spiral fibres twisted in two opposite directions, the external from before backwards, the internal from behind forwards. This arrangement, which was first observed in the Ruminantia, was supposed to explain the process of rumination. This opinion, however, is refuted by the fact that the arrangement is not confined to this order, but is very general among the zoophagous and other animals which do not ruminate. In the kangaroo the direction of these fibres is, as in man, transverse in the internal layer, and longitudinal in the external.

The œsophageal mucous membrane is covered by epidermis, which extends to the cardiac opening of the stomach in man, the Quadrumana, and all the Zoophaga. This membrane, as well as the mucous, is thrown, by the action of the muscular tunic, into longitudinal folds, which are effaced only when the œsophagus is distended. In the tiger, lion, and lynx, there are large transverse valvular folds, and smaller ones in the civet and couguar—an arrangement connected probably with the carnivorous habit.

Stomach.

The stomachs of the lower animals vary considerably in shape, in the insertion of the œsophagus, in the disposition of their muscular tunics, and in the simplicity or complication of their cavities. These characters it is impossible in such a sketch as the present to consider in detail; and we shall confine our attention to those peculiarities which are most striking in the digestive organs of the animal world.

Simple stomach.

The stomachs of the Mammalia may be distinguished into the simple and compound. Those of man, the Quadrumana, zoophagous and most of the herbivorous tribes, belong to the former order. This simple form of stomach, however, may be generally distinguished into two parts, a cardiac and a pyloric, more or less separated from its other by a central transverse contraction of its annular muscular fibres. This is particularly seen in the horse, man, murine family, and many other animals which occasionally feed both on animal and vegetable matter. In the human stomach this contraction is represented in Plate XXXVI. fig. 4. In the porcupine, however, there are three pouches. This contraction depends on a strong annular band of muscular fibres at this part of the organ. In the pure carnivorous animals, however, as the feline family, the annular fibres, which are very thick, are nearly equally so from the cardiac to the pyloric end.

The compound stomachs, or those which contain more cavities than one, are found in the sloths, and the ruminant and cetaceous animals chiefly.

Bilocular stomach.

In the first tribe the stomach of the *Unau*, or two-toed sloth, is two-fold. The first cavity is large and globular, but tapering behind into a conical appendage, separated by a semilunar fold; while a large cul de sac on the left of the *cardia* opens into a canal which proceeds at first backwards, and then turning to the right, enters the second cavity by a narrow aperture. The second, which is small, tubular, and folded under the former from left to right, is distinguished by a semilunar fold into two halves, the first of which opens into a small cul de sac on the right side of the first cavity. The inner membrane of both cavities is smooth, and without *villi*. A similar arrangement is found in the *Ai*, or three-toed sloth, with this exception, that the appendage of the second gastric cavity is divided into three compartments by two longitudinal bands. This canal seems analogous to the arrangement of the ruminating stomachs, in so far as it may allow the alimentary matters to pass occasionally from the œsophagus directly into the second stomach.

The stomach of the *hyrax*, ashkoko, or Cape cavy, also consists of two pouches, separated by a middle partition, in which there is an aperture for mutual communication. In the hippopotamus the cardia communicates with three pouches, two of which only are cognizable without, and with a long tubular bowel, the interior of which is divided across by several valvular folds.

In the kangaroo the stomach receives the œsophagus near its left extremity, which is small and bifid (Plate XXXV. fig. 8); and forming a larger cavity on the right, passes upwards, making a turn, and crosses to the left before the œsophagus, makes another turn, and again crosses the mesial plane to the right, where it terminates in a tapering cavity at the pylorus. In this course it presents internally a longitudinal band (L, L, L), extending all round to near the pyloric end, and crossed by valvular membranous folds, which divide the cavity into cells not unlike those of the colon, especially in the horse. The mucous epidermis is continued from the œsophagus over the space marked *c*, *c*.

Quadrilocular stomach of the ruminants.

The stomach of the Ruminants consists of four distinct but communicating cavities. The first, denominated the Paunch (*κοιλια*, *rumen*, *penula*, *ingluvies*; *la panse*, *l'herbier*, *la double*), is a large bag occupying the left side of the abdomen chiefly, marked externally by two saccular appendages, and separated within into four parts. (Plate XXXV. fig. 1, A, A, A, A.) Its inner surface, upon which the epidermis is continued, is occupied by flat *papillæ*. By a pretty wide aperture (B, B), with rounded margins, this communicates with the second cavity named the Kingshood (*κεκρυφαλος*, *reticulum*, *le bonnet*), which is distinguished by the rhomboidal and polygonal cells, into which its inner membrane is moulded. An aperture at the further end of this (C) leads into the third or smallest cavity, termed the Maniplies (*εχινος*, *omasum*, *le feuillet*), from the numerous concentric crescentic folds formed by its inner membrane (fig. 2, *c* and P). These folds amount to about 40 in the sheep and 100 in the ox. The smallest of them, between the aperture from the second into the third cavity, are puckered or collected towards their further end by a transverse membranous fold, which acts as a valve to the aperture between this and the fourth cavity. This one, generally named the Red (*ηνυστρον*, *abomasum*, *la caillette*), is of an elongated pyriform shape, slightly incurvated on itself (fig. 2, D), and is marked internally by longitudinal folds (P) incurvated according to the curvature of the cavity itself, and terminating near the pyloric end in *rugæ* or irregular duplicatures (R). This is the structure of the gastric cavities in the ox.

In the camel, dromedary, and lama, the stomach is equally complicated, though the structure is a little different. In the first of these animals, which may be taken as an example of the others, the Paunch or first cavity is a large bag, divided into two compartments on the posterior part, by a strong band passing from the right side of the cardiac orifice longitudinally downwards (L, L, fig. 3), and forming one border of a groove leading to the orifice of the second. From the left margin of this band proceed eight muscular bands, nearly at right angles, and intersecting with others, form cellular cavities on the left side of the paunch (N); while on the right side there are similar cells, though smaller, and wholly unconnected with the longitudinal band. From the left margin of the cardia, in like manner, proceeds a broad muscular band (M, fig. 3) to the aperture (B) of the Paunch into the Kingshood, after which it takes another direction (M, fig. 4) towards the Maniplies or third cavity, within the orifice of which it terminates (C, fig. 4) The Red or fourth chamber is much the same as that of the bullock (D, P, R, fig. 5), and the only peculiarity is, that after terminating in (Π) the pylorus, it opens in a small cavity (O) which leads into the duodenum (Δ).

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Water-cells of the camel.

From this description, for the particulars of which we are indebted to the accurate account of Sir E. Home, it results that the stomach of the camel differs from that of the ox and other horned ruminants chiefly in the possession of the quadrilateral cells in the second stomach. Into these the water is conveyed by the animal when drinking, and in these it remains. By the action of the muscular band (M), the aperture between the Paunch and Kingshood is opened, and the water is directed into it so as to fill its cells. When these are filled the surplus runs off into those of the first stomach, where at least those on the left side of the long band may be regarded as part of the general cellular structure. These cells are represented of a large size in fig. 5, in which they appear like oblongs with rounded corners. They are always larger on the left side of the band, in the Paunch, than those in the second stomach.

Both in the bullock and in the camel, and in all the Ruminants, the first and second stomachs only are covered by mucous *epidermis*.

Quadrilocular stomach of the Cetacea.

In the Cetaceous animals similar complication of the gastric cavities is observed. In the bottle-nose porpoise, which may be taken as an example, the œsophagus, which is large and capacious, terminates in a spheroidal or ovoidal flask-like bag (fig. 6, A, A) with an aperture a little below the cardiac, consisting of rose-like annular folds, and leading into a second cavity. This, which corresponds to the ruminant kingshood, is nearly spherical in shape (fig. 7, B), and presents valvular folds more circular than in the ruminants, and intersected by others so as to give it the honeycomb appearance characteristic of this cavity. From this another aperture leads into the smallest cavity of the three (C, fig. 7); and thence into the fourth, which is long, cylindrical, and slightly incurvated. The third cavity is remarkable for presenting in its inner membrane numerous apertures of mucous glands.

Crop of birds.

Birds are distinguished by possessing a stomach consisting of three cavities. The first is the crop, which may be regarded as a mere expansion of the œsophagus, and confined chiefly to land birds. It is filled not only with food, but with small stones; and its chief purpose seems, by mechanical comminution, to supply the place of the teeth in dividing the granular aliment, and bruising or killing the animals swallowed. It is found chiefly in the granivorous birds. It is wanting in the ostrich, in the piscivorous birds, and most of the GRALLÆ.

Glandular crop.

The second is the glandular crop or subsidiary stomach (*ventriculus succenturiatus, bulbus glandulosus*), a membrano-glandular sac, which may be also regarded as an œsophageal dilatation. It is larger when the crop is wanting; and though, when conjoined with it, it is always very glandular, and may be therefore regarded as a chemical solvent of alimentary substances, it appears to supply the want of the crop, which is certainly chiefly a mechanical apparatus. The glandular crop or subsidiary stomach is remarkable for the number and size of the glandular bodies contained between its mucous and muscular tunics. These glands, though variable in shape, are generally conical; and some consist of several glands conjoined in one common peduncle (Plate XXXVI. fig. 3). All of them are hollow, and secrete a fluid which is discharged by one or more minute apertures, and which is of essential importance in the solution of the food. In some instances, as in the American ostrich (fig. 2), they are few in number, and occupy only a small part of the posterior wall of the œsophagus.

Gizzard.

The gizzard or proper stomach of birds may be considered as a horny mucous membrane, somewhat cartilaginous, continuous with that of the œsophagus, and covered by two strong thick muscles, the fibres of which converge to a point. (Plate XXXVI. fig. 1.) In the carnivorous and piscivorous *genera* of birds, especially those in which the crop is wanting, the gizzard loses its muscular character, and is converted into a membranous pouch.

Reptile stomach.

The stomach of REPTILES does not present those dilatations observed in BIRDS; and when it changes its diameter or capacity, it is only progressively and insensibly. Its general diameter, nevertheless, is proportionally larger than in the two classes already noticed. Most generally without *cul de sac*, its shape is spheroidal, more or less oblong; its membranous walls are thin and transparent; its muscular layer almost imperceptible; the cellular identified with the mucous tissue; the situation of the *cardia* indeterminate; and the *pylorus*, without valve, is distinguished by a simple tapering contraction of the gastric walls, and the appearance of the structure proper to the intestines.

In this class of animals, further, digestion appears to be less regulated by fixed principles than in the other two. It is evidently not confined exclusively to the stomach. The œsophagus of the turtle is provided with numerous large, firm, pointed processes, which in all probability contribute to the mechanical division of the food, so much the more requisite as the CHELONIAD REPTILES are toothless. Except in the crocodile, the SAURIAL Reptiles are destitute of large arch or proper cardiac cavity. In the OPHIDIAL or Serpentine Reptiles the stomach has the figure merely of a dilated sac between the œsophagus and intestines, and presents no curvature. It is probably in connection with this modification of structure that we find animals remain for days in the œsophagus of serpents; and this tube appears to be to a certain extent capable of digesting aliment as much as the stomach. The best mark of distinction in such circumstances is the cessation of *epidermis*.

Stomach of fishes

In no class of animals does the stomach vary more in shape, structure, and situation, than in FISHES; and perhaps the general character of the alimentary canal in this class is most justly given by representing it as deviating from those attributes of regularity which we find in the higher classes. While in the MAMMALIA and BIRDS it is always distinguished by its spheroidal or pyriform enlargement between two tapering extremities, and by being much more dilated than any other part of the alimentary canal, in the Reptile class it begins to part with this character; and it loses it altogether in the Fishes. In most of the finny tribes it is often not more capacious than the œsophagus; and it is distinguished from this tube only by the villous character of its internal membrane. In general, also, the situation of this pyriform dilated sac is transversely across the body in the Mammiferous class. In the feathered tribes this character also is slightly set aside, and partly from the alteration in shape, partly from that of position, the stomach occupies less of the transverse diameter than of the longitudinal extent of the body. Among the Reptiles this character, though still retained in the CHELONIAD, and even in the SAURIAL, is gradually enfeebled in the OPHIDIAL; and in the FISHES it may be said to be entirely obliterated, since the organ occupies much more longitudinal extent than transverse width of the body.

The first character of the alimentary tube of fishes is the width or capacity combined with shortness of the œsophagus. The latter character is manifestly associated with the absence of lungs and consequent want of chest; so that between the throat and abdominal cavity, the interval, which corresponds only to the space occupied by the heart, is extremely abridged. The œsophagus consists, as in the other classes, of a mucous membrane surrounded by a muscular tunic; but the mucous membrane is distinguished by the firmness and whiteness of its corion, which in some *genera* approaches to the consistence of horn or cartilage, and by the presence of conical *papillæ*, sometimes of great hardness, and which appear to

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act mechanically on the food. It is almost superfluous to notice the facility which the large capacity of this tube affords fishes for swallowing their prey. Most of them are voracious in the extreme; and it is not uncommon to find the stomach and œsophagus crammed to the throat.

The figure and position of the stomach of Fishes are so variable, that it is difficult to give a character of general application. Though in many *genera*, especially of the JUGULARES, it consists of a cylindrical sac with a slight dilatation immediately below the *cardia*, in others it is oblong ovoidal, as the ray and shark tribe; and in others, as the sole, dory, and flat fishes generally, it is orbicular. In the sturgeon it consists of a cylindrical tube incurvated twice on itself. In none is there more than one *cul de sac*, the depth of which varies as the part corresponding to the *pylorus* is more or less remote from the *fundus*. When the limits of the stomach are indistinct, the situation of the cardia is equally so. In the lamprey (*petromyzon*) and pen-fish (*syngnathus pelagicus*) the whole tube is of a uniform size from the mouth to the anus; and much the same may be said of the carp genus. The genera in which it forms a distinct dilatation or cul de sac are chiefly the following; the eel (*murœna anguilla*), conger (*m. conger*), the bullhead *genus* (*cottus*), the *scorpœna horrida*, *labrus genus*, perch, cuckoo gurnard, mackerel, herring, salmon, *mormyrus genus*, mullet, and *silurus Bagre*. In the anableps the dilatation disappears; and in the *chœtodon ciliaris* and some others it is a large sac incurvated in an arch-like bend.

The intestinal canal in most of the Mammalia is very similar to that of man; and the chief differences of different orders and genera are found in the difference of longitudinal extent either of the whole intestinal tube or the comparative lengths of its several parts.

Comparative length of the intestine to the body.

From the time of Grew to that of Cuvier, and most modern anatomists, it has been a point of some importance to determine the length of the intestinal tube in relation to that of the body. This comparative length, which is greatest in the MAMMALIA, diminishes successively in the BIRDS, REPTILES, and FISHES. It has been occasionally stated by different anatomists, that the intestinal tube is longer, *cæteris paribus*, in granivorous than in carnivorous animals, and conversely. When we come, however, to compare the different lengths of this tube in the several tribes, we find that this statement demands modification. In the ape family its length varies from 5 to 8 times that of the body; in several of the *lemur* tribe from 4 to 6 times, the smaller length being in this case compensated by the size of the *cæcum*; and in others of the lemur tribe, *e. g.* the *lori*, the intestine is only three times the length of the body. Among the CHIROPTERA there are two examples of very great contrast in this respect. While the intestine of the *noctula* or great bat (*vespertilio noctula*, Lin.) is the shortest of all the MAMMALIA, and scarcely does more than exceed the length of the animal's body, that of the roussette (*pteropus*) or East India bat, which lives chiefly on vegetable matter, is at least 7 times longer than its body. A similar instance of the meeting of extremes is found in the Marsupial order, in which the marmoset and cayopollin have intestines only $2\frac{1}{2}$ times longer than the body, while that of the phalanger is more than 11 times longer. In the plantigrade or ursine family, which occasionally live on vegetable matters, the proportional length approaches to that of the ape.

In the carnivorous animals the intestine, though generally short, varies from 3 times to 8 times the length of the body. The former is the proportion in the lion, wild cat, ocelot, couguar, and weasel; and the latter in the hyena. Some of them also vary among themselves. Thus the intestine of the wild cat is greatly less than that of he domestic animal. The proportion is very great among the RODENTIA, in several of which it is 8, 10, 12, or 16 times longer, as in the agouti, than the body of the animal. Among the murine tribe, however, it undergoes a diminution. Among the EDENTATA, again, especially the sloth tribe, it diminishes very much, being only about $3\frac{1}{2}$ times longer than the body in the *Ai* and *Unau*. This brevity is so much the more extraordinary that these animals are void of cæcum, and live on vegetable matters; but, in all probability, the duplicature of the gastric cavities in some degree compensates this deficiency.

The intestinal tube attains its greatest proportional length in the Ruminant animals, being at least 11 times longer than the body, as in the goat, and 28 times longer in the ram. This immense length is supposed to compensate the absence of dilatation in the large intestines, and the small size of the cæcum. In the SOLIDUNGULA, again, which are remarkable for the large size of the cæcum, the length of the intestine diminishes much, being 8 times longer than the body in the zebra, 9 times in the ass, and 10 times in the horse.

Lastly, it is a singular circumstance, that in different species of the same genus the comparative length varies much. We have already noticed the difference between the length of the intestine in the wild and in the domestic cat. The wild and tame boar is a similar instance of the same, the intestine being only 9 times longer than the body in the former, and so much as $13\frac{1}{2}$ times in the latter. It is possible that such differences may depend on the different habits of the animal in his wild and domestic condition. This explanation, however, is totally inadequate to account for the difference in the comparative length of the intestinal tube in the Asiatic and African elephant, being 10 times longer than the body in the former species, and only 7 times in the latter. The same may be observed of two animals very closely allied, if not of the same *genus*, the *echidna* and *ornithorhyncus*. The intestine of the former animal is 7 times longer than his body, while that of the latter is only 5 times.

In BIRDS generally the intestine is shortest among those genera which prey on animals and fish; it varies from twice to five times the length of the body. In the gallinaceous and passerine birds, which live on grains, it is always longer and more capacious than in those which live on animal substances. In the cassowary, which is granivorous with a short intestine, the intestine is divided by contractions into distinct pouches, to compensate for the brevity of the tube. It must be remarked, nevertheless, that in several birds which prey on fishes, the intestinal tube is proportionally longer than in those which feed only on grain; and the proportional length is not diminished in birds living indiscriminately on animal and vegetable aliment.

The intestinal tube of the Reptiles is still shorter than that of Birds, and often it does not exceed twice the length of the body. It is longest in the CHELONIAD, and shortest in the RANINE and SERPENT tribe. In the tadpole, however, a singular peculiarity is observed. The intestinal tube of the tadpole of a frog is nearly ten times longer than the space between the muzzle and the vent (*anus*); whereas, after the animal has become a frog, the intestine is only twice as long as this space.

In the class of Fishes the intestinal tube is still shorter and more direct in its course to the vent or outlet. In a few which live chiefly on marine vegetables, for instance some of the *chætodon genus*. it is about six times longer than the body of the animal; and in a few of the carp *genus* (viz. *cyprinus capæta*) it amounts to ten or twelve times longer than the body. In others, however, of the same genus, for instance the *cyprinus mursa*, it is scarcely as long again, showing here once more an instance of the conjunction of extremes not easily explained.

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Distinction into *ileum* and *colon*.

In most vertebrated animals the intestinal tube may be distinguished by natural marks into two divisions, one extending between the pyloric end of the stomach to a part of the tube, where it becomes wider and more capacious; the other from this to the vent or outlet. In some instances, however, this distinction is very obscurely and imperfectly marked. In the MAMMALIA, in which the distinction is observed, it is indicated by one or more appendages, which, if large, are denominated *cæca*, and if slender and long, are termed *vermiform processes*. Man, the ourang, and the wombat (*phascolomys*), are the only animals which are possessed at once of *cæcum* and vermiform appendage. In the other genera of the ape tribe, in the maki of the *lemur*, in the colugo among the CHIROPTERA, the ichneumon, many of the carnivorous tribe, the opossum and kangaroo, the RODENTIA except the dormouse, the Cape ant-eater, the PACHYDERMATA except the hyrax, the Ruminants, SOLIDUNGULA, and AMPHIBIA, there is only a cæcum without vermiform process. The cæcum is wanting in the sloths, the bat tribe, the Ursine except the ichneumon, the marten, pine-marten, weasel, &c. the dormouse, and all the Cetaceous animals.

The presence of cæcum or vermiform process, however, is not necessary to distinguish the canal into two portions. The inner or mucous surface of the *ileum* is always villous and uniform; and the whole intestine, except its superior or pyloric portion, is convoluted in proportion to its length, and moves about freely in the abdominal cavity; whereas the colon is more or less fixed at different points, it is shorter and more capacious, and its inner membrane is merely mucous without long *villi*. A mark equally general is the semilunar duplicature of mucous membrane placed between the ileum and colon, and named the *ileo-colic* valve. In the sloth and armadillo tribes, which want cæcum and vermiform process, this and the slight difference of diameter are the only marks of distinction between the ileum and colon. In all the other MAMMALIA which are destitute of cæcum the whole tube is of the same calibre, occasionally diminished towards the vent; and the division into *ileum* and *colon* is no longer cognizable.

In all the MAMMALIA with one cæcum, it appears in the form of a production from the large intestine beyond the part at which it receives the *ileum;* and though variable in its diameter and structure, it bears a general resemblance to the colon in these respects. In herbivorous animals, and even in some that are omnivorous, as the ape and lemur tribes, it is generally large and puckered by tendinous bands. To this, however, an exception is observed in the Ruminants, in which the cæcum is moderate in size and unpuckered. It is small and unpuckered in the kangaroo-rat and wombat; while, conversely, in the colugo and brown phalanger, which are believed to be chiefly zoophagous, it is very large and puckered.

In the zoophagous animals generally both the *colon* and *cæcum* are of small calibre, little different from that of the *ileum;* and both the colon and cæcum are destitute of cells or compartments. In herbivorous and several omnivorous animals, on the contrary, the inner surface of the colon is divided by longitudinal and transverse bands into a number of cells or compartments. From this rule, however, there is an exception in the wombat, kangaroo, and the Ruminants. In the RODENTIA the colon is cellular at its commencement only.

In birds the canal is provided with two *cæca*, one on each side, not far from the vent. In the omnivorous and granivorous these *cæca* are generally long and capacious. While they are very large in the nocturnal predatory birds, they are either obliterated or wanting in the diurnal predatory birds, in the green woodpecker, the lark, and the cormorant. In the heron, bustard, and grebe, there is a single small one; in the cassowary two very slender; and in the merganser, diver, &c. they are short and thick.

In all birds the short bowel between the insertion of the *cæca* and the *cloaca* is a little wider and more capacious than those between the *pylorus* and the *cæca;* and this is the only circumstance which indicates in this class the distinction of the tube into *ileum* and *colon*.

In the reptiles the intestinal tube is generally void of *cæca* or appendage; and the only distinction consists in the one part of the tube, which is long and slender, being joined to another which is short and thick, and in the presence of a semilunar membranous fold at the point of insertion. In the *iguana* alone has a genuine *cæcum* been observed.

The distinction into small and large intestine, or *ileum* and *colon*, is still less obviously observed in the class of fishes. It sometimes happens that the difference of capacity is inverted, and that the calibre of the portion which terminates at the vent is actually smaller than that of the part connected with the stomach. This arrangement is observed in the ray, shark, sturgeon, and even the bichir; in the *syngnathus*, trunk-fish, and *balista*. In other instances the diameter is the same throughout; and the only distinction is derived from the anatomical characters of the inner membrane. In the lamprey, sea-devil, rough star-gazer, radiated sole, *holocentrus sago*, carp tribe, *mormyrus*, and mullet, it is impossible to distinguish the intestine into large and small.

Pyloric appendages of fishes.

FISHES resemble REPTILES in being destitute of *cæcum* at the junction of the small and large bowel. In many of them, however, there is attached to the intestine, somewhere below the *pylorus*, a variable number of small intestines terminating in blind ends, similar in size and structure to the intestine with which they communicate. These tubes, which have been not very happily named *pyloric* appendages (*appendices pyloricæ*), in so far as they are most frequently connected rather with the part of the bowel corresponding to the duodenum, vary in number from 2, 4, 6, or 8, to 80 or 180 in some genera, and even their number is not the same in different species of the same genus. Thus, while there are 6 in the smelt (*salmo eperlanus*), there are 68 in the *s. lacustris*, and 70 in the salmon (*s. salar*). In like manner, though there are 18 in the anchovy (*clupea encrasicolus*), there are 24 in the herring (*c. harengus*), and fourscore in the shad (*c. alosa*). In some, as the cod and pollach, they consist of several large trunks ramified into numerous small ones.

Peculiar form of the appendages.

These appendages, however, are wanting in the cartilaginous fishes with free *branchiæ*, in most of those with fixed *branchiæ*, in the APODES, and in several of the thoracic and abdominal order. In the sturgeon and some others they are represented by a series of communicating cavities inclosed in the intestinal membrane, which is covered by a cellulo-muscular tunic and peritoneum (Plate XXXVI. fig. 5), and which assumes the external appearance of a pancreas.

The spiral valve of fishes.

Among the cartilaginous fishes the brevity and directness of the intestinal tube is compensated by a peculiar disposition of the intestinal mucous membrane. This consists in part of the membrane projecting like a broad fold or process from the inner surface of the intestine, and winding round from the pyloric to the anal or lower extremity (fig. 7 and 8). This, which is denominated the spiral valve, may be easily understood from these figures, which represent the arrangement as it is observed in the shark. In the sturgeon, in which it is found in the last portion of intestine (fig. 6), its peculiarities have been described by the writer of this article in the *Wernerian Transactions*, vol. vi.

Rectum.

In all the MAMMALIA the intestinal tube terminates in a distinct bowel denominated the *rectum*, the mucous membrane of which is continuous with the skin at the

anus. This rule can scarcely be said to be violated in the case of the *echidna* and *ornithorhyncus*, in which there is an aperture at the lower part for the urine and the semen of the male and the *ova* of the female. These anomalous and singular animals form a transition to the mode in which the intestinal tube terminates in the three genuine oviparous classes. In BIRDS, REPTILES, and most of the cartilaginous FISHES, the intestinal tube terminates in an outlet common to it with the urinary organs, denominated generally the *cloaca*. In the sturgeon, however, it has been shown, in the paper already mentioned, that there is a distinct urinary outlet; and that consequently this animal cannot be said to have a *cloaca*. In the greater part of fishes, while there is one vent for the excrement, there is another common one for the urine, the *ova*, and the spawn.

Cloaca.

On the subject of the liver, spleen, and pancreas, it is impossible to enter with any interest in this sketch.

CHAP. II. SECT. I.—THE HEMATROPHIC ORGANS.

The Mammalia and Birds agree in having a heart consisting of two pairs of chambers, a venous auricle and ventricle, and an arterial auricle and ventricle. The Eustachian valve is often wanting in the Mammalia. It is wanting, for instance, in the lion, bear, and porcupine; while it is broad and muscular in the seal, and assumes a spiral direction along the upper walls of the right auricular sinus in the elephant.

It was at one time imagined that the aquatic MAMMALIA were distinguished from the terrestrial by the *foramen ovale* being open and forming a communication between the two auricles. This, however, is a mistake, at least in the adult animal; for neither in the otter, the seal, nor the porpoise or dolphin, did Cuvier find this aperture pervious; and it may be inferred, that when it is open, it is an anormal remain of the fetal structure. In the *ornithorhyncus*, also, according to Sir Everard Home, it is impervious. In the porcupine and elephant, in which there are two anterior *venæ cavæ*, the blood of the left anterior *cava*, which opens in the sinus near the aurico-ventricular aperture, is conveyed directly into the right ventricle.

The reptile heart, the first in the cold-blooded division, varies somewhat in the several tribes. In the first three, the CHELONIAD, SAURIAL, and OPHIDIAL, it consists of two auricles and one ventricle, divided in some instances into communicating chambers. In the Batrachoid family, on the contrary, it always consists of one auricle and one ventricle, the interior of which is unilocular or undivided. In several of the Turtle tribe, among the first family, the ventricle consists of a pulmonary chamber, in which the blood is more particularly directed to the pulmonary artery, and a general or aortic chamber, which is above, and from which the blood is conveyed into the aorta. In the crocodile the ventricle is divided into three chambers, communicating by several apertures. One is inferior and to the right, and communicates with the right auricle by a large aperture provided with two valves. On the left, and before, is the second chamber, receiving the orifice of the left descending aorta. Behind is an aperture leading into the smallest chamber of the three, situate at the middle of the base of the heart, and receiving the common trunk of the pulmonary arteries. The left chamber is above. In the OPHIDIAL or SERPENTINE family the ventricle is divided into two chambers, a superior and inferior, separated by an imperfect partition, which allows the two to communicate.

The heart of the finny tribes is as simple as that of the Ranine reptiles, which indeed constitutes the preparatory step in the descending scale of organic forms. It consists, as in these animals, of two chambers only, an auricle and ventricle. The former receives the blood from the body at large, and transmits it to the ventricle, which is almost in all cases unilocular. From this a single vessel conveys it, not to the body at large, but to the gills, from which it is again collected by several branchial veins.

Of the blood-vessels of the four vertebrated classes it is superfluous to speak in any detail.

The most remarkable circumstances are the minute subdivisions which in some classes the arteries undergo previous to final distribution. In the Ruminants, and several of the PACHYDERMATA, the branches of the carotid artery, instead of uniting by the communicating vessels, are subdivided into a great number of minute vessels, which form round the pituitary gland a communicating plexus, denominated by the ancients *Rete mirabile*.

In the slow lemur (*lemur tardigradus*) Sir A. Carlisle found the subclavian artery, after entering the axilla, divide into 23 arterial cylinders of equal size, and the iliac on the brim of the pelvis into at least 20 equal-sized tubes, which in both cases surrounded the principal artery, reduced to a small vessel, and, proceeding along the extremity, were distributed chiefly to the muscles. (*Phil. Trans.* 1800.) A similar arrangement, carried to a still greater extent, was found in the *Ai* or three-toed sloth, in which the axillary and iliac arteries were divided into about 60 or 65 cylindrical parallel tubes. In the slender lemur (*Lemur loris*) these vessels are subdivided into 4 or 5 only.

In Fishes in which the unilocular ventricle sends its blood to the gills only, the heart is pulmonary, and the arterial system is destitute of central impulsive organ. In the sturgeon, which is one of the best examples of the distribution of the arterial system in the finny tribes, the blood, which is distributed in the *branchiæ* by the large artery, is collected in numerous vessels, which may be regarded as analogous to the pulmonary veins of the warm-blooded classes, but which have thick *parietes* like arteries; and these uniting, form a large vessel, which is lodged in a cartilaginous canal formed by the continuous bodies of the *vertebræ*. This vessel is further void of compressive or elastic tunics, and the blood moves through it as through an immovable and inelastic tube. From its sides, however, a series of arterial vessels issue, which forthwith assume the usual characters of arterial tubes. In many other fishes the *parietes* of the large artery adhere in part to the semi-osseous canal in which it is lodged.

SECT. II.—THE ORGANS OF AERATING CIRCULATION.

The lungs of the MAMMALIA are in all essential points perfectly similar to those of the human subject.

The lungs of Birds differ chiefly in not presenting distinct lobules, in having the air-vessels larger and more distinct, in the branchial tubes not becoming quite so small, and in terminating not alone in the pulmonic vesicles, but in perforated parts of the surface of the lungs, which lead into large air-sacs, communicating with all parts of the body, and forming an accessory lung. In the ostrich, which may be taken as a general example, there are four of these cells or aerolabous sacs. The first, which is anterior, extends from the *apex* of the chest to the iliac bones, between the first ribs and heart above, and between the lower ribs and a cell which surrounds the intestines. It is divided into four chambers, the first two communicating with the lungs by large apertures, while the fourth opens in the iliac bones. Behind this large sac are two small ones, between the iliac bones and the peritoneal sac. Before it is another small one occupying the lateral regions of the *apex* of the chest, and communicating with sacs in the *axillæ* and neck. Besides these, the stomach, liver, heart, and intestines are surrounded by sacs. All of these communicate by saccular processes with the cavities of the bones. By this peculiar arrangement BIRDS possess the greatest extent of respiratory surface of all classes of animals.

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The lungs of Reptiles are distinguished by consisting of large sacs, subdivided by membranous partitions into polygonal cells, which again are subdivided by smaller slips into smaller cells. In these cells the bronchial tubes are not ramified, but divide abruptly in them at the surface of the lung. Some idea of this arrangement may be obtained from the lung of the ordinary land-tortoise (*Testudo Græca*, Plate XXXVII. fig. 1). The sacs or large cells are smaller and more numerous in the turtle (fig. 2); but the general disposition is much the same.

Temporary gills of the tadpole.

The young of the Batrachoid family, and several of the water-lizard tribe, are provided with fimbriated or ciliated processes attached to the neck, and which are in all respects similar to the gills of fishes. These gills disappear as the animal grows; and when it assumes the true ranine or reptile character, vesicular lungs like those of other reptiles, and which had continued in a hitherto latent and rudimental state, are developed, and the animal breathes as others of the same tribe.

A peculiar form of respiratory organ is found in the lamprey or seven eyes, and the two species of hag-fish, (*Myxine*, Lin.; *Gastrobranchus*, Bl.; and *Gastrobranchus Dombey*). The former has on each side seven apertures leading into cylindrical tubes, in which the branchiæ are contained. (Plate XXXVII. fig. 3.) In the two species of hag these tubes are dilated into ovoidal cavities, in which the water is received, and on the membrane of which the branchial vessels are distributed. In this respect, therefore, the hag-fish approaches to the mode of respiration among the cephalopodous MOLLUSCA, in which the *branchiæ* are inclosed in a cavity. Lastly, in the *Aphrodite aculeata*, which may be taken as an example of the respiration of worms, there is a series of tubes like *tracheæ* and *bronchi*, proceeding from the surface to the interior, and in which the water containing the air requisite for respiration is received. (Fig. 6.)

SECT. III.—SECRETORY ORGANS.

Urinary organs of the oviparous classes.

Under this head ought to be described the urinary organs of the four vertebrated classes. Those of the MAMMALIA agree in consisting of kidneys more or less lobulated, ureters or excretory tubes, a reservoir or urinary bladder, and a urethra opening on the same mucous surface with the organs of generation. In the three oviparous classes considerable changes are made. Though in Birds and Reptiles the glandular organs denominated kidneys are left in the shape of aggregated glands with the two excretory tubes, the bladder is withdrawn, and the ureters open in the *cloaca*. The only apparent exceptions are the ostrich and cassowary, in which the *cloaca* is so organized that it may serve as a bladder or temporary receptacle of the urinary secretion. In the Reptiles the presence of this organ is variable, being found in the CHELONIAD and BATRACHOID; and the iguana, tupinambis, chameleon, stellio, and dragon, among the SAURIAL tribe; but wanting in the crocodile, lizard, *agami*, gecko, and the whole OPHIDIAL tribe. In Fishes it is not less variable. While the ray and shark tribe are destitute of bladder, and the ureters terminate in a *cloaca*, this receptacle exists in the sea-devil, lump-fish, globe-fish, and others of the cartilaginous division.

Poison gland and fangs of serpents.

A peculiar secreting organ, deserving notice, is the poison gland of the poisonous serpents. It is a glandular body situate on each side above the upper jaw, behind and below the eyes, with a considerable cavity, which opens into a long excretory tube, lying along the outer surface of the upper jaw, and opening in the tubular tooth, represented at fig. 17 and 18; and which is movable in an articulation, and may be erected, as in fig. 18, or depressed, as in 16, at the will of the animal. The poisonous serpents are therefore distinguished from the innocuous by the presence of the erectile movable tubular fangs. Fig. 15 is the head of the innocuous, and 16 of the poisonous serpent.

PART III.—REPRODUCTIVE ORGANS.

Under this head we mention only the nipple-bag (*marsupium mammillare*), or secondary uterus of the Marsupial animals (Plate XXXVII. fig. 7); the nipples (fig. 8); and the manner in which the fœtal animal, in a very imperfect and embryal form, becomes attached by the mouth to the nipples (fig. 10). The *Marsupium*, therefore, ought to be regarded, not as a mere pouch in which the young may take refuge after they are grown, but as a subsidiary *uterus*, combining the character of the *Mammæ* of the other orders.

The MAMMALIA are peculiar in possessing a *uterus*. In the other classes this organ is withdrawn, and the ovary (fig. 11) and oviduct alone are left. In the ovo-viviparous animals, as the ovo-viviparous shark, the oviduct (fig. 12) resembles that of the common fowl. In the lower classes the ova are hatched out of the body entirely.

In the space assigned to this article, it was impossible to treat fully of a subject so extensive as the structure of the animal world; and while the author has arranged its divisions in such a manner as to show in what order it may be most easily and advantageously studied. he has introduced only those topics which are most indispensable, and most require illustration. For more complete details, therefore, he refers the reader to the following works.

1. *Leçons d'Anatomie Comparée* de G. Cuvier, Membre de l'Institut National, &c.; recueillies et publiées sous ses yeux par C. Duméril, chef des Travaux Anatomiques, &c. Cinq tomes. Paris, tome i. 1799;—tome v. 1805. 2. Blumenbach's *Manual of Comparative Anatomy;* with additional Notes by William Lawrence, Esq. F. R. S. Second edition, revised and augmented by William Coulson Lond. 1827, 8vo. The notes are derived chiefly from the work of Cuvier and the papers of Sir E. Home in the *Philosophical Transactions.* 3. Gore's Translation of *Carus's Introduction to the Comparative Anatomy of Animals.* Lond. 1827, 2 vols. 8vo. The arrangement of this work, in which the author examines the forms of organs as they ascend, from the lowest to the highest classes, diminishes its general interest. 4. *Lectures on Comparative Anatomy, in which are explained the Preparations in the Hunterian Museum.* By Sir Everard Home, Bart. Lond. 1823, 6 vols. 4to. This work consists of the papers read by the author at the Royal Society, and published in their Transactions. Though entitled, therefore, *Lectures on Comparative Anatomy*, it embraces a much more extensive field, and contains a great number of physiological and pathological papers. This renders it at once rather desultory and prolix. It contains, nevertheless, a great number of facts illustrative of peculiarities of structure in the animal world; and it is particularly valuable by the number of engravings with which it is embellished. It can scarcely be said to possess any arrangement whatever. 5. *Recherches sur les Ossemens Fossiles, où l'on rétablit les caractères de plusieurs animaux dont les Révolutions du Globe ont détruit les espèces.* Par M. le Bar. G. Cuvier, &c. Nouvelle édition. Tome i. 1822, Osteology of the Elephant, Hippopotamus; tome ii. partie i. 1822, Osteology of the Rhinoceros, Horse, Hog, Daman, and Tapir; tome iv. 1823, Osteology of the Deer and Ox, the Bear, Hyena, Lion, Glutton, Wolf, and Dog; tome v. partie i. 1823, Osteology of the Reptiles, the Ichthyosaurus and the Plesiosaurus; partie ii. 1823, RODENTIA, EDENTATA, MONOTREMA, AMPHIBIA, and CETACEA. Paris, 1824. These papers contain much accurate osteological description.

(D. C.)

Anatomy Act || Anaxagoras.

Anatomy Act, and Anatomical Schools. Notwithstanding the reputation to which a few British anatomists have attained within the last hundred years, before the passing of the *Anatomy Acts* of 1831 and 1832 the study of practical anatomy in Great Britain was all but proscribed by statute. Early, it is true, in the sixteenth century, by way of encouraging anatomical studies, it was ordained that "the bodies of four murderers should be delivered after execution to the corporation of *barber-surgeons* of London, for the purposes of dissection;" and at that time we were not much behind the rest of Europe in anatomical knowledge: but our legislation regarding the supply of bodies for the dissecting-room remained stationary, while the rest of the world was advancing, as became apparent by the fact, that until the middle of the last century our students were forced to seek anatomical knowledge in the various schools of Italy or of Holland. Yet our courts of law were in the habit of punishing medical men for professional ignorance, and our public boards of requiring anatomical skill in those who appeared before them for examination, while the laws prohibited the means of obtaining it at home; and it was even penal for any one to be in possession of a human body for anatomical purposes, except it were that of an executed murderer.

In defiance, however, of such strange discouragements, anatomy, especially in London and Edinburgh, made much progress, by the public winking at notorious transgressions of the law; but this anomalous state of things produced a class of offenders termed *body-snatchers*, whose revolting and, in some instances, atrociously criminal modes of supplying the dissecting-room were exposed in the parliamentary inquiry that preceded the Act now noticed.

By previous Acts of Parliament the criminal courts had been empowered to annex to the capital sentence on a murderer, that his body should be *publicly dissected*. But it was justly considered that thus the idea of great crime was connected with dissection, and the prejudices of all classes against anatomy greatly increased. Accordingly, in the second year of William IV., a parliamentary committee investigated the subject, and in the following year an act was passed that abolishes *dissection* as a part of any criminal sentence, legalizes schools of anatomy, and permits the possession of human bodies for the purpose of dissection, under judicious regulations, which are sufficient to prevent the revolting practices of the body-snatcher, and the still more atrocious crimes for which Bishop in London and Burke at Edinburgh were executed. Under this act the supply of bodies in our anatomical schools has been sufficient, without violating the sepulchres of the dead, or outraging the feelings of the living. The average supply of bodies to the London schools is estimated at 600 annually.—See *Report of House of Commons, of 22d April* 1829; *and Anatomy Bills of 5th May* 1829, *of 17th December* 1831, *and of 8th May* 1832.

ANAXAGORAS, an eminent philosopher of antiquity, was born at Clazomenæ (now *Kelisman*), in the first year of the 70th Olympiad, or 500 B.C. (*Apollodorus*). His family was rich and noble, but he early sacrificed the prospects of worldly ambition to his passion for philosophy. Leaving his patrimony to be cultivated and enjoyed by his relations, he gave himself up to the contemplation of nature, which he regarded as the true object of man's existence. "To philosophy," he afterwards said, "I owe my worldly ruin, and my soul's prosperity." Some writers call him the pupil of Anaximenes; but this statement, if taken literally, is irreconcileable with chronology. According to others, he enjoyed the instructions of his countryman Hermotimus, who, according to Aristotle, was the first to proclaim the doctrine of a supreme regulative intelligence. At the age of 20, or according to others, of more than 40, he went to Athens, at that time entering on the most brilliant period of its history, and there continued for 30 years. His philosophical teachings soon drew around him the best intellects of Athens, and he numbered among his pupils Pericles, Euripides, Archelaus, and probably also Socrates. Without interfering in the public affairs of the state, he contented himself with forming the minds of its rising youth in the principles of wisdom. But neither the elevation and disinterestedness of his character, nor the powerful friendship of Pericles, could ward off the shafts of persecution. The philosopher was accused, like Socrates in the next generation, of impiety (ἀσέβεια) and enmity to religion, in introducing new and dangerous opinions concerning the gods. He was charged, among other things, with teaching that the moon was but a mass of matter like the earth, and the sun (the bright Apollo) a fiery mass of inanimate substance. The philosopher was tried and condemned to die; but the eloquence of Pericles procured the commutation of the sentence into a fine and banishment. Anaxagoras retired to Lampsacus, where he continued to teach philosophy till his death in the 73d year of his age, B.C. 428. "It is not I," said he in his exile, "who have lost the Athenians, but the Athenians who have lost me." The day of his death was for several centuries commemorated by a yearly holiday, called the *Anaxagoreia*, in all the schools of Lampsacus.

Anaxagoras.

Opinions the most contradictory have been attributed to this philosopher. From the fragments that survive of his writings, and the statements of others regarding his opinions, it is impossible to obtain a systematic view of his doctrines. Diogenes Laertius, in his *Life of Anaxagoras*, has collected, with little care and judgment, details which were scattered through various writings. It appears that, in the midst of some extravagant conceptions, Anaxagoras held opinions which indicate a considerable acquaintance with the laws of nature. His idea of the heavens seems to have been that they were a solid vault, originally composed of stones elevated from the earth by the violent motion of the ambient ether, inflamed by its heat, and by the circular motion of the heavens fixed in their respective places. He considered the sun to be a fiery mass of stone *larger than the Peloponnesus*; and Xenophon introduces Socrates as refuting that doctrine, and delivering an unfavourable opinion concerning his other writings. The moon he believed to be *inhabited*, and to have its light reflected from the sun. Hence we find his disciple, Euripides, calling the moon not the *sister*, but the *daughter*, of the sun. From his perceiving that the rainbow is the effect of the reflection of the solar rays from a dark cloud, and that wind is produced by the rarefaction, and sound by the percussion of the air, he seems to have paid considerable attention to the phenomena of nature.

Our information is more correct concerning his opinions of the principles of nature and the origin of things. He imagined that in nature there are as many kinds of principles as there are species of compound bodies; and that the peculiar form of the primary particles of which any body is composed is the same with the quality of the compound body itself. For instance, he supposed that a piece of gold is composed of small particles which are themselves gold, and a bone of a great number of small bones: thus, according to Anaxagoras, bodies of every kind are generated from similar particles. The universe, according to him, consisted in the beginning of an infinite variety of these elementary principles (ὁμοιομέρη), which were afterwards mixed and arranged by the moving force of intelligence (νοῦς). "He was the first," says Diogenes Laertius, "who superadded mind to matter, opening his work in this pleasing and sublime language:—"All things were confused; then came mind and disposed them

in order." Aristotle, in like manner, says, that he taught that intelligence was "the cause of the world, and of all order; and that while all things else are compounded, this alone is pure and unmixed." Reason (λόγος) he held to be the regulative principle of the mind, as the *nous* is of the universe. The senses inform us regarding external phenomena; but this information, he held, required the correction of reason. The fragments of Anaxagoras have been collected by *Schaubach*, Leipsic, 1827, and again in a better edition by *Schorn*, Bonn, 1829.

ANAXARCHUS, a Grecian philosopher, who lived under Philip of Macedon and Alexander, was born in Abdera, and belonged to the sect generally known by the name of the Eleatic. He is said to have been instructed in his early studies by Diomenes of Smyrna, or Metrodorus of Chios. He had the honour to be a companion of Alexander; and a few anecdotes transmitted to posterity concerning him render it evident that he treated him with the usual freedom of a friend. He checked the vain-glory of Alexander, when, elated with pride, he aspired to the honours of divinity, by pointing to his wounded finger, saying, "See the blood of a mortal, not of a god." We are likewise told, that, on another occasion, while the king was indulging immoderately at a banquet, the philosopher repeated a verse from Euripides, reminding Alexander of his mortality. It is, however, to be regretted, that the fidelity of the philopher was wanting at the time when the mind of Alexander was tortured with remorse at having slain his friend Clitus; for it is reported that on that occasion he endeavoured to soothe the agitated mind of Alexander by saying, that "kings, like the gods, could do no wrong." It is said that Nicocreon, tyrant of Cyprus, commanded him to be pounded in a mortar, and that he endured this torture with incredible patience; but as the same fact is reported of Zeno the Eleatic, there is reason to suppose that it is fabulous; and it may be added, that this narrative is inconsistent with the general character of Anaxarchus, who, on account of his easy and peaceable life, received the appellation of "The Fortunate." Regarding his philosophical doctrines we have no information, save that he held the sovereign good to consist in perfect tranquillity of mind (ἀπάθεια).

ANAXILAUS of Larissa, a physician and Pythagorean philosopher, was banished from Rome by Augustus, B.C. 28, on the charge of practising the magic art. This accusation appears to have originated in his superior skill in natural philosophy, or what may be called "natural magic."—Euseb. *Chron. ad Olymp.* clxxxviii; St Iren. i. 13; Plin. xix. 4, xxv. 95, xxviii. 49, xxxii. 52, xxxv. 50.

ANAXIMANDER, a famous Greek philosopher, a friend or pupil of Thales, was born at Miletus in the 42d Olympiad, in the time of Polycrates, tyrant of Samos, 610 B.C., and died at the age of 63. He was the first who publicly taught philosophy, or wrote upon philosophical subjects, and carried his researches very far into nature. It is said that he discovered the obliquity of the zodiac, was the first who published a geographical table, invented the gnomon, and set up the first sun-dial in an open place at Lacedæmon. The primary essence he held to be infinite (ἄπειρον), all-embracing, and divine; that this infinite always preserved its unity, but that its parts underwent changes; that all things came from it; and that all returned into it. According to all appearance, he meant by this obscure and indeterminate principle the chaos of the other philosphers. He asserted that there is an infinity of worlds; that the stars are composed of air and fire, which are carried in their spheres, and that these spheres are gods; and that the earth is placed in the midst of the universe, as in a common centre. He added, that infinite worlds were the product of infinity, and that corruption proceeded from separation.

ANAXIMENES, an eminent Greek philosopher, born at Miletus; the friend, scholar, and successor of Anaximander. He diffused some degree of light upon the obscurity of his master's system. He made the first principle of things to consist in the air, which he considered as immense or infinite, and to which he ascribed a perpetual motion. He asserted that all things which proceeded from it were definite and circumscribed; and that this air, therefore, was God, since the divine power resided in it and agitated it. Coldness and moisture, heat and motion, rendered it visible, and gave it different forms, according to the different degrees of its condensation. All the elements thus proceed from heat and cold. The earth was, in his opinion, one continued flat surface.

ANAXIMENES, a Greek historian and rhetorician, was born at Lampsacus, a city of Mysia in Asia Minor, in the fourth century B.C. Some writers ascribe to him the Treatise on the Principles of Rhetoric, which bears the name of Aristotle; and it is reported that Philip of Macedon invited him to his court to instruct his son Alexander in that science. He attended Alexander in his expedition against Persia. The history of Philip, of Alexander, and likewise twelve books on the early history of Greece, were the productions of his pen, but only a very few fragments exist.

ANAZARBUS, or ANAZARBA, in *Ancient Geography*, a city of Cilicia, on the left bank of the Pyramus, eleven miles from Mopsuestia. Augustus changed its name to Cæsarea (ad Anazarbum), and on the division of Cilicia it became the metropolis of Cilicia Secunda. It suffered severely from earthquakes in the reigns of Justinian and Justin. Its site is supposed to be the present Anawasy or Naversa.

ANBAR, a town of Asia, in Arabian Irak, on the Euphrates. It was taken by Khaled, lieutenant of the khalif Omar, in the year 634, and rebuilt by the first khalif of the Abbassides. It is 35 miles west of Baghdad. Long. 43. 2. E. Lat. 33. 15. N. This is also the name of a fortified town in Independent Tartary, 20 miles north-east of Khiva.

ANBERTKEND, the Hindustanee name of a celebrated book of the Bramins, wherein the Indian philosophy and religion are contained. The word in its literal sense denotes *the cistern wherein is the water of life.* The Anbertkend is divided into 50 beths or discourses, each of which consists of 10 chapters. It has been translated from the original Indian into Arabic, under the title of *Morat al Maani*, q. d., *the marrow of intelligence.*

ANÇA, a small town of Portugal in the province of Douro, near Coimbra. It has extensive quarries of a fine bluish-white stone, which is exported in considerable quantities.

ANCASTER, a parish of Lincolnshire, once a Roman station, and considered by many antiquarians as the Causennæ of Antoninus. Area 2800 acres; pop. in 1851, 589.

ANCENIS, an arrondissement in the department of the Loire-Inferieure, in France. The extent is 305 square miles, or 195,436 acres. It is divided into five cantons, and these into 27 communes. Population in 1851, 48,102. The chief place, of the same name, contains 3661 inhabitants.

ANCESTORS, those from whom a person is descended in a direct line. The word is derived from the Latin *ancessor*, contracted from *antecessor*, goer before. Many nations have paid honours to their ancestors. It was properly the departed souls of their forefathers that the Romans worshipped under the denominations of *lares, lemures*, and *penates*, or *household gods.* Hence the ancient tombs were a kind of temples, or rather altars, whereon oblations were made by the kindred of the deceased.

ANCHISES, in *Fabulous History*, a Trojan prince, the son of Capys, and descended from Dardanus. He was honoured with the affections of the goddess Venus, who bore him a son named Æneas, the hero of the Æneid.

ANCHOR, in *Navigation*, from the Greek ἄγκυρα, which Vossius thinks is from ὄγκη, a *crook* or *hook*, an instrument of iron or other heavy material used for holding ships in any situation in which they may be required to lie, and preventing them from drifting by the winds or tides, by the currents of rivers, or any other cause. This is done by the anchor, after it is let down from the ship by means of the cable, fixing itself into the ground, and there holding the vessel fast. The anchor is thus obviously an implement of the first importance in navigation, and one on which too much attention cannot be bestowed in its manufacture and proper construction, seeing that on it depends entirely the safety of the vessel in storms. The invention of so necessary an instrument remounts, as may be supposed, to the remotest antiquity. The most ancient anchors consisted merely of large stones, baskets full of stones, sacks filled with sand, or logs of wood loaded with lead. Of this kind were the anchors of the ancient Greeks, which, according to Apollonius Rhodius and Stephen of Byzantium, were formed of stone; and Athenæus states that they were sometimes made of wood. These sorts of anchors retained the vessel merely by their inertia, and by the friction along the bottom. Iron was afterwards introduced for the construction of anchors, and also the grand improvement of forming them with teeth or flukes to fasten themselves into the bottom; whence the words ὀδόντες and *dentes* are frequently taken for anchors in the Greek and Latin poets. The invention of the teeth is ascribed by Pliny to the Tuscans; but Pausanias gives the merit to Midas, king of Phrygia. Originally there was only one fluke or tooth, whence anchors were called ἑτερόστομοι; but shortly afterwards the second was added, according to Pliny, by Eupalamus, or, according to Strabo, by Anacharsis, the Scythian philosopher. The anchors with two teeth were called ἀμφίβολοι or ἀμφίστομοι, and from ancient monuments appear to have been much the same with those used in our days, except that the stock is wanting in them all. Every ship had several anchors, the largest of which, corresponding to our bower or sheet anchor, was never used but in extreme danger, and was hence peculiarly termed ἱερά or *sacra;* whence the proverb *sacram anchoram solvere*, as flying to the last refuge.

Antiquity of anchors.

Weight of anchors of different sizes.

Anchors are now universally made of wrought iron, excepting in Spain and some parts of the South Sea, where they are made of copper. One essential quality in every anchor is a sufficient weight and angle of arm and fluke to fix itself in the bottom; and this has been determined by practice for different anchors, and for vessels of different sizes.

Large vessels have several anchors of different sizes, which are stowed in different parts of the vessel. These are distinguished by different names, viz., the *best bower* to the starboard; and the *small bower* to the port cathead, with the flukes on the bill-board; the *sheet-anchor*, on the after part of the fore-channels on the starboard side; and the *spare-anchor* on the port side. The above anchors are of the same size and weight. The two latter are only let go in cases of danger, when the vessel is riding in a heavy gale. In men-of-war they are always kept ready for letting go. The *stream-anchor* is of a much smaller size than the above, used only for riding in rivers or moderate streams. It is not generally above one-fourth or one-fifth of the weight of the others. Lastly, the *kedge-anchor* is still smaller, being only about one-half of the stream-anchor, and is only used when kedging in a river. Ships of the large class carry four large and three small anchors, and the smallest class, as brigs, cutters, and schooners, three or four.

The weight of anchors for different vessels is allowed by the tonnage. A pretty near rule for the principal anchor of ordinary-sized vessels is to allow for the cwts. in the anchor one-twentieth of the tonnage. Thus a vessel of 400 tons would require her principal anchor to be 20 cwt., or according to the following tables:—

MERCHANT VESSELS.

Tonnage. Tons.	Cable Chain. Inches.	Weight of Anchor. Cwt.
20	$\frac{9}{16}$	1
35	$\frac{11}{16}$	$1\frac{3}{4}$
50	$\frac{3}{4}$	$2\frac{3}{4}$
65	$\frac{13}{16}$	$3\frac{1}{2}$
70	...	$4\frac{1}{2}$
80	$\frac{7}{8}$	5
100	$\frac{15}{16}$	$5\frac{3}{4}$
130	1	7
160	1	8
190	$1\frac{1}{8}$	$9\frac{1}{2}$
220	$1\frac{1}{8}$	$10\frac{1}{2}$
250	$1\frac{3}{16}$	12
280	$1\frac{1}{4}$	14
320	...	$15\frac{1}{2}$
380	$1\frac{3}{8}$	$17\frac{1}{2}$
430	$1\frac{7}{16}$	20
480	$1\frac{1}{2}$	21
520	$1\frac{1}{2}$	25
720	$1\frac{11}{16}$	33

VESSELS OF WAR.

Guns.	Tonnage.	Cable Chain. Inches.	Weight of Anchor. Cwt.
20	500	$1\frac{3}{8}$	25
24	700	$1\frac{1}{2}$	29
28	750	$1\frac{1}{2}$	33
32	920	$1\frac{5}{8}$	38
36	970	$1\frac{5}{8}$	41
38	1000	$1\frac{3}{4}$	44
40	1100	$1\frac{3}{4}$	47
44	1300	$1\frac{3}{4}$	50
50	1500	$1\frac{7}{8}$	61
64	1600	2	65
74	1900	2	72
80	2500	$2\frac{1}{8}$	85
90	2600	$2\frac{1}{4}$	92
100	2700	$2\frac{1}{4}$	94
120	3000	$2\frac{1}{4}$	99 to 100

Form and dimensions of anchors.

Next to the weight, the form of the anchor, and the proportions of the different parts, are of great importance. The most general form, and that which has indeed been almost universally adopted all over the world, is that represented at Plate XXXVIII. fig. 1, and in section at Plate XXXIX. fig. 1, consisting of the two hooked arms for penetrating and fixing themselves into the soil; the long bar or shank for attaching the cable; and the stock, which is attached to the extremity of the shank, and serves to direct one of the points downwards into the soil. The weight of the anchor then causes the point to penetrate more or less according to the softness or hardness of the bottom; and the action of the vessel on the cable, instead of loosening the anchor, tends rather, by the hooked shape of the arms, to fix these deeper and firmer into the soil; so that the vessel is held quite fast, unless either the cable itself gives way, or any part of the anchor, or the anchor is dragged along owing to the looseness of the soil. The cable draws upwards by the extremity, and turns the whole round the point of the fluke. The one end of the shank is made square, to receive and hold the stock steadily in its place without turning. To keep the stock also from shifting along the shank, there are raised on it from the solid iron, or welded on it, two square tenon-like projections, called nuts. The length of the square of the shank is about one-sixth of the whole length of the shaft, and the thickness about one-twentieth. From the end of this square the shank increases in thickness, tapering towards the extremity, where the arms are attached: in all this part it is either made wholly round, or with a flat on opposite sides, or polygonal. The end next the stock is called the *small round*. The other extremity, where the arms and the shank unite, is called the *crown*, and the point of the angle between the arms and the shank the *throat*. Here the thickness of the shank is from $1\frac{1}{2}$ inch in small anchors, to 3 inches in large ones, greater than at the small round. A distance equal to that between the throat of one arm and its bill is marked on the shank from the place where it joins the arms, and is called the *trend*. Near the extremity of the square part of the shank is the hole for receiving the *shackle* for the cable, which is about half the thickness of the small round, and the diameter nearly equal to the length of the square. The shackle is lapped with cordage to prevent the cable from chafing. When hempen cables are used in her Majesty's service, one length of bower chain cable called a *ganger*, is bent to the spare anchor, and the hempen cable united with Admiral Elliott's shackle.

The *arms* make an angle of about 56° with the shank.

They are made either round or polygonal like the shank, about half their length. The remainder of the arm consists of three parts, the *blade*, the *palm*, and the *bill*, Plate XXXIX. fig. 1, and in another view at fig. 2. The blade is merely the continuation of the arm in a square form. The palm or fluke is a broad, flat, triangular plate, fixed on the inside of the blade, the use of which is, by exposing a broad surface, to take a firmer hold of the ground. The bill is the extremity of the arm, where it is tapered nearly to a point, for the purpose of penetrating more readily into the soil. In some cases the arm is made quite straight from the crown to the bill; in others, and particularly in small anchors, the interior half is made with the arch of a circle. The whole length of the arm is nearly half the length of the round part of the shank. It tapers slightly from the throat to the blade, where it is about the same thickness with the small round of the shank. The palm is about one-third of this in thickness, and the breadth of its base is nearly equal to its length.

The *stock* of the anchor, represented at fig. 3, is made of oak, consisting of two beams embracing the square, and firmly united by iron bolts and hoops. The length of the stock is rather greater than that of the shank, the thickness in the middle about one-twelfth of its length, and tapering to about the half of this at the extremities, the taper being all on the under surface next the arms, and the other quite straight. The taper is not quite regular. It commences at about half the breadth of the stock from the shank, and continues in one straight line to the extremity. The beams of the stock are hooped close together at the extremities, but gradually open towards the centre, that, in case of the wood shrinking, the hoops may be driven farther in, fig. 4. Of late years the stock has frequently been made of wrought iron, the same as the anchor; and this plan is now very generally followed in anchors up to sixty cwt. It has this advantage, that the stock can be at any time taken out and laid parallel with the anchor, which is very convenient for stowage. The iron stock, fig. 10, consists merely of a long round bar, about half the diameter of the anchor at the square. Instead of embracing the anchor, like the wood, it goes through a hole in the square, which is swelled out to receive it. It has a shoulder in the middle, which rests against the square, and a key driven through a hole in the stock on the other side keeps it fast. When the stock is to be taken out of its place, the key is driven out: the stock then slides through the hole in the shank, and by means of a bend at its extremity, it is laid parallel with the shank.

The operation of the anchor is easily understood. Being let down by means of the cable, the weight of the arms throws them downwards, and keeps the whole in a vertical position until it reaches the ground, where it lights upon the crown; and then falling over, the position of the stock at right angles to the arms, and its length and height, together with the weight of the cable, are sure to throw it with one of the arms pointed into the ground, if it does not take this situation of itself. This effect is aided by the anchor descending quickly—and hence it must be allowed to descend freely; for which purpose, in *throwing* or *casting* the anchor, the cable is arranged, one end being attached to the anchor and the cable bitted on deck, and the inner end removed below. Everything being prepared, the lashing of the anchor is cast off, and the men stand ready to let go; and when this word is given by the person in command, the fastenings are all cast off, and the anchor, falling into the sea, descends with rapidity. When the anchor, again, is to be removed from its situation and drawn up into the vessel, the operation is termed *weighing;* which requires often a very heavy purchase, particularly at starting. This is obtained by means of the windlass or capstan, round which the cable is wound, and a number of hands applied to work it. With cables which are too large to be wound round a windlass, a smaller rope or chain is used, termed a messenger, which, being attached to the cable at different points, and wound round the capstan, serves to bring the cable forward. But since the introduction of chain-cables this contrivance is not so much required.

When the anchor is brought above water, a tackle from the cathead, called the cat, is hooked on to the shackle of the anchor, and hoisted up; the cathead stopper is then passed, viz., one end of it is fastened round the cathead, and the other is brought through the shackle of the anchor, then over the stopper-cleat, and is belayed round a timber head; the cat is then unhooked, and another tackle called the fish is hooked on just within the flukes, and the arms are hove up so as to lie upon the gunnel, or bill-board; the stock is then made vertical by hauling upon another tackle, called the stock-tackle, in which position the anchor is secured by the stock-lashing for sea. In the event of bad weather, and before commencing a long voyage, the cathead stopper and shank painter is doubled.

The following table contains the dimensions of the parts of anchors of different weights. The letters G. L. denote the greatest and least diameters or breadths.

Weight.	SHANK.							SQUARE.						ARMS.					PALMS.			
	Sizes.							Sizes.				Shackle.		Sizes.							Thickness.	
	Length.	Throat.		Trend.		Small.		Length.	Breadth at the Root.		Hole from End.	Extreme Diam.	Diam of Iron.	Length.	Throat.		Small.		Length.	Breadth	Mdle.	Edge.
Cwt.	ft. in.	G. in.	L. in.	G. in.	L. in.	G. in.	L. in.	ft. in.	G. in.	L. in.	in.	ft. in.	in.	ft. in.	in.	in.	in.	in.	ft. in.	ft. in.	in.	in.
$2\frac{1}{4}$	4 8	$3\frac{15}{16}$	$3\frac{5}{16}$	$3\frac{3}{16}$	$2\frac{7}{8}$	3	$2\frac{3}{8}$	1 0	$2\frac{5}{8}$	$2\frac{1}{16}$	$2\frac{1}{4}$	0 8	$1\frac{3}{8}$	1 $6\frac{5}{8}$	$3\frac{14}{16}$	$3\frac{5}{16}$	3	$2\frac{3}{8}$	0 $8\frac{3}{4}$	0 8	$\frac{3}{4}$	$\frac{9}{16}$
$7\frac{1}{8}$	7 1	$5\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{3}{8}$	$4\frac{9}{16}$	$4\frac{9}{16}$	$3\frac{3}{4}$	1 $6\frac{1}{2}$	$4\frac{1}{8}$	$3\frac{3}{8}$	$2\frac{3}{4}$	1 $1\frac{1}{2}$	$2\frac{3}{8}$	2 $4\frac{3}{8}$	$5\frac{7}{8}$	$5\frac{1}{8}$	$4\frac{9}{16}$	$3\frac{3}{4}$	1 $1\frac{3}{8}$	1 $0\frac{1}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$
8	7 5	$6\frac{1}{8}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$4\frac{13}{16}$	$4\frac{3}{8}$	4	1 $7\frac{1}{2}$	$4\frac{5}{16}$	$3\frac{5}{8}$	3	1 $1\frac{1}{2}$	$2\frac{3}{8}$	2 $5\frac{5}{8}$	$6\frac{1}{8}$	$5\frac{3}{8}$	$4\frac{3}{4}$	4	1 $2\frac{1}{8}$	1 $0\frac{3}{4}$	$1\frac{3}{16}$	$\frac{7}{8}$
$28\frac{1}{2}$	11 3	$9\frac{5}{16}$	$8\frac{5}{16}$	$8\frac{9}{16}$	$7\frac{9}{16}$	$7\frac{3}{8}$	$6\frac{3}{8}$	2 $5\frac{1}{2}$	$6\frac{3}{16}$	$5\frac{3}{4}$	$4\frac{3}{8}$	1 $7\frac{1}{2}$	$3\frac{1}{2}$	3 9	$9\frac{5}{16}$	$8\frac{5}{16}$	$7\frac{3}{8}$	$6\frac{3}{8}$	1 $9\frac{1}{8}$	1 $7\frac{1}{4}$	$1\frac{13}{16}$	$1\frac{3}{8}$
$49\frac{1}{2}$	13 6	$11\frac{3}{16}$	$9\frac{7}{8}$	$10\frac{5}{16}$	$8\frac{15}{16}$	9	$7\frac{9}{16}$	2 11	$8\frac{5}{16}$	$6\frac{15}{16}$	$4\frac{7}{8}$	1 10	4	4 6	$11\frac{13}{16}$	$9\frac{7}{8}$	9	$7\frac{3}{16}$	2 $1\frac{3}{8}$	1 $11\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{5}{8}$
$73\frac{3}{4}$	15 4	$12\frac{11}{16}$	11	$11\frac{13}{16}$	$10\frac{1}{1}$	$10\frac{3}{8}$	$8\frac{9}{16}$	3 $3\frac{5}{8}$	$9\frac{7}{16}$	$7\frac{3}{4}$	$5\frac{1}{2}$	2 $0\frac{1}{2}$	$4\frac{9}{16}$	5 $1\frac{3}{8}$	$12\frac{11}{16}$	11	$10\frac{3}{8}$	$8\frac{3}{16}$	2 $4\frac{7}{8}$	2 $2\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{7}{8}$
$90\frac{3}{4}$	16 $5\frac{1}{2}$	$13\frac{7}{16}$	$11\frac{1}{2}$	$12\frac{9}{16}$	$10\frac{5}{8}$	$11\frac{1}{16}$	$9\frac{1}{8}$	3 $6\frac{3}{8}$	$10\frac{1}{16}$	$8\frac{1}{8}$	$5\frac{7}{8}$	2 2	5	5 $5\frac{7}{8}$	$13\frac{7}{16}$	$11\frac{1}{2}$	$10\frac{1}{16}$	$9\frac{1}{8}$	2 7	2 $4\frac{1}{8}$	$2\frac{11}{16}$	2
94	16 $8\frac{1}{2}$	$13\frac{5}{8}$	$11\frac{5}{8}$	$12\frac{3}{4}$	$10\frac{3}{4}$	$11\frac{3}{16}$	$9\frac{3}{16}$	3 7	$10\frac{1}{16}$	$8\frac{3}{16}$	6	2 $2\frac{1}{2}$	$5\frac{1}{8}$	5 $6\frac{3}{4}$	$13\frac{5}{8}$	$11\frac{5}{8}$	$11\frac{3}{16}$	$9\frac{3}{16}$	2 $7\frac{3}{8}$	2 $4\frac{5}{8}$	$2\frac{3}{4}$	2
100	17 1	$13\frac{7}{8}$	$11\frac{15}{16}$	$12\frac{15}{16}$	$10\frac{7}{8}$	$11\frac{7}{16}$	$9\frac{7}{8}$	3 $7\frac{1}{2}$	$10\frac{3}{8}$	$8\frac{5}{16}$	$6\frac{1}{3}$	2 3	$5\frac{3}{16}$	5 $8\frac{3}{8}$	$13\frac{7}{8}$	$11\frac{15}{16}$	$11\frac{7}{16}$	$9\frac{3}{8}$	2 $8\frac{1}{8}$	2 $5\frac{1}{4}$	$2\frac{7}{8}$	$2\frac{1}{8}$

Besides anchors of the common construction, there are various others of different forms occasionally in use. Small vessels often employ what are termed *grapnels*, which are merely common anchors with four or more arms instead of two, as shown in fig. 6. Following out the same principle, we have the *mushroom* anchor, fig. 7, much employed in the East Indies, to secure the vessels which they term grabs. In this the arms are continued in one segment of a sphere all round; it hence requires no stock, as it takes the ground in any direction. Attempts have frequently been made to introduce anchors with only one arm, but hitherto without any decisive result. A patent for an anchor of this kind, as represented at Plate XXXIX. fig. 8, was taken out by Mr Stuard, which has attracted some notice. "In order," says he, in the specification of his patent, "that this anchor may be sure to fall the right way with the fluke downwards, I would have the shank very short, whereby, when suspended by the cable, it will cant the most, and when it has hold in the ground, the ship will ride safer; as a long shank has more power to loosen and break the ground, and is more likely to be bent or broken from its hold. Let the form of the shank and arm of the anchor be as AA, fig. 8; and, that the parts may be stronger than if made separately and shut together, I would have the bars which compose them in one length, so that there be no weld or joining in the whole length of the shank and arm. The hole B is to receive the ring for the cable, and the hole C is for the stock, which is composed of a wrought-iron bolt, as A, fig. 8, covered with cast-iron at its ends, BB. The palm to be in shape as D, fig. 8, made either entirely of cast-iron, or cast-iron shell filled with lead, which is of much more specific gravity than iron. The back of the palm to be formed either with concave surfaces or flat surfaces, making angles at the centre. The anchor is also to have a small shackle, fixed on the bend of the shank and arm, as at E, fig. 8, for the buoy-rope to be made fast to. The shank may be made without the hole C, and the hole B made octagonal; or if round, it should have a small fillet projecting from the stock, and a small cavity on one side of the hole B to receive it, thus to prevent the stock from turning round; and instead of a ring for the cable, to have a shackle fitted on the stock, on each side of the shank; and, that the shackle may not turn on the stock and fall too low, a stop is to be fixed on each side at the upper end of the shank."—See *Repertory of Arts*, &c., vol. v.

New mooring anchor.

Mooring Anchors are those which are fixed in certain situations in harbours or roadsteads, and to which any of the vessels frequenting the place may be secured. As these are no way limited as to weight like portable anchors, they often consist merely of a large block of stone, such as at fig. 9, with an inner ring fixed in the middle of the upper side; or several such stones may be fastened together so as to act as one mass. Mooring anchors are also often made by choosing one of the largest anchors used for first-rate ships, weighing 80 cwt., and by bending one of the arms close down upon the shank, to prevent it catching hawsers when transporting ships, nets of fishermen, fouling, &c. These anchors are lowered down into the water with a very strong iron mooring chain fastened to the ring, to which the ships are fastened: they are usually made from such as are damaged in one of the flukes or arms. A new kind of mooring anchor of cast-iron was described by Mr Hemman of Chatham, to the *Society for the Encouragement of Arts, &c.*, in 1809, for which he obtained a silver medal from the society. Fig. 5, Plate XXXIX., represents the palm or heavy part of the anchor, made very massive of cast-iron, and of considerable breadth, so that the edge B, or part which enters the ground, may have a great hold; the shank C is made also of cast-iron, and fixed firmly to the head by passing through it, and has a small ring at *a*, where the buoy-rope is fixed; the other end of the shank goes through the stock *dd*, which is formed of two large wooden beams hooped together in the same manner as the stocks for common anchors; the end of the shank projects through the stock, and has a strong wrought-iron shackle E fixed to it by a bolt passing through both, and with this the mooring chain is connected. The great advantage of this over the common mooring anchors arises from its great weight and breadth of edge to act against the ground, and being made of cast-iron. A pair of these anchors, weighing 150 cwt. each, will, with the mooring chains, cost about L.874 less than a pair of the common anchors, which, with their chains, cost L.2472.—See *Transactions of the Society for the Encouragement of Arts, &c.*, vol. xxviii.

Floating-anchor.

This is the name given to a sort of anchor which has often been proposed, but never reduced to practice, for preventing a vessel from drifting, in cases where the great depth of the sea precludes the use of the cable and ordinary anchor. The plan suggested by Dr Franklin seems the most rational. This anchor consisted of two cross bars, secured together in the middle, and having sailcloth fastened to them in the shape of a parallelogram. To the centre of these bars the cable was attached, and being thrown overboard, it was thought the resistance of so large a surface would at least check the rapidity of the ship's motion.

The following is Mr Aylen's plan for anchoring in deep water out of soundings, to prevent vessels from drifting in a calm when in a tide-way, or if disabled:—Hoist out immediately one of the boom-boats, let go the kedge anchor, and veer out 40 or 50 fms. over the bow, and stop it to the ring in the bow and stern of the boat, then veer out from the ship from 70 to 80 fms.

Much attention has been paid of late to the improvement of the manufacture of anchors, and several specimens were sent by the makers to the Royal Exhibition in 1851.

A committee, consisting of five shipowners of London, Liverpool, and Glasgow, with five nominated by the Lords of the Admiralty, was appointed to test the relative merits of these. After trying, on the parade ground of Sheerness dockyard, on the beach at Garrison point, at Blackstakes in the River Medway, and at the Nore, those that were submitted for competition, viz., Admiralty, Aylen's (a modified Admiralty), Honiball (or Porter's), Isaacs' (United States), Lenox's, Mitcheson's, Rodgers', and Trotman's (an improved Porter's), they reported in 1853 that, taking into consideration the results of all the trials to which the anchors had been subjected, they thought it best to record their opinions in the following tabulated forms:—

TABLE showing the relative order in which the several anchors stand with regard to each of the properties essential to a good anchor: the names arranged alphabetically. (Plate XL.)

ANCHORS.	Strength computed from first crack.	Holding long and short scope.	Facility of stowing.	Quick holding.	Quick tripping.	Exemption from fouling.	Facility of sweeping.	Facility of transport in boats.	Fishing in a heavy seaway.	Canting.
Admiralty	4	5	1	2	1	4	1	2	2	2
Aylen	7	4	1	2	3	4	1	2	2	5
Honiball (or Porter's)	2	2	3	4	2	1	4	3	5	3
Isaacs	1	6	4	5	1	1	4	4	5	1
Lenox	6	3	2	1	2	3	2	1	3	2
Mitcheson	Refused this trial.	1	3	1	3	2	3	2	4	4
Rodgers	5	2	1	1	2	4	2	1	1	2
Trotman	3	1	3	3	4	1	4	3	5	5

TABLE shewing the estimated numerical values of the several Anchors in regard to the properties considered essential to a good Anchor.

Note.—This Table only professes to show approximate values, and has no pretensions to mathematical accuracy or precision.

ANCHORS.	Strength computed from the first crack.	Holding long and short scope.	Facility of stowing.	Quick holding.	Quick tripping.	Exemption from fouling.	Facility of sweeping.	Facility of transport in boats.	Fishing in a heavy sea-way with present fish-hook.	Canting.	Total values.
Proportionate values of the Qualities.	15	80	10	15	5	10	5	5	10	5	160
Admiralty	2·07	6·42	1·82	2·01	·89	·65	·95	·65	1·98	·73	18·17
Aylen	1·89	9·10	1·82	2·01	·45	·65	·95	·65	1·98	·44	19·94
Honiball (Porter's)	2·33	10·69	·91	1·53	·67	1·85	·29	·52	·55	·60	19·94
Isaacs	2·63	5·	·45	·59	·89	1·85	·29	·26	·55	·81	13·32
Lenox	1·92	9·56	1·36	2·36	·67	1·11	·71	·87	1·32	·73	20·61
Mitcheson	Refused this trial.	14·10	·91	2·36	·45	1·39	·57	·65	·88	·52	21·83
Rodgers	1·94	10·69	1·82	2·36	·67	·64	·95	·87	2·19	·73	22·86
Trotman	2·22	14·44	·91	1·77	·31	1·85	·29	·52	·55	·44	23·30
Totals	15·00	80·00	10·00	14·99	5·00	9·99	5·00	4·99	10·00	5·00	159·97

The following is a recapitulation of the order in which the anchors were ranked by the committee, together with their relative per-centage of inferiority or superiority to the Admiralty anchor, the value of which, as given in the foregoing table (18·17), was taken as the standard or unit.

Trotman......... 1·28 or 28 per cent.		Superior to Admiralty Anchor.
Rodgers......... 1·26 or 26 do.		
Mitcheson....... 1·20 or 20 do.		
Lenox........... 1·13 or 13 do.		
Honiball......... 1·09 or 9 do.		
Aylen............ 1·09 or 9 do.		
Admiralty....... 1· the standard.		
Isaacs............ ·73 or 27 per cent. inferior to Admiralty.		

Mr Jonathan Aylen's temporary anchor, Plate XXXIX., made from a broken bower, a stream, and kedge anchor, was completed in four hours (without removing the broken anchor from the bows), on board H.M.S. Hastings of 74 guns, in the Bay of Beyrout in October 1840. That ship having parted the small bower cable, and broken the shank of the best bower anchor, after having previously supplied a ship with one of her spare anchors, was left with only one bower anchor.

Mr Aylen when in command of H.M.S. Rhadamanthus having lost two bower anchors, in Dingle harbour on the west coast of Ireland, rode out a heavy gale in 1847, with his temporary bower anchor.

Supposing both the flukes, and about two feet of the shank and crown of the anchor is gone (invariably the place where all anchors break), the weight of the broken part would be about half the weight of the original, say

	Cwt.
Bower anchor for the Hastings class 74 cwt., half	37
Stream anchor and stock for the above ship,	22
Kedge and stock for do.	11
	70

In making anchors in the Royal dockyards, the different parts are forged by the steam hammers. In the first place, large slabs or pieces are made about five feet long, and three of them put together, soundly welded, and drawn out of sufficient length for the shank; the arms and palms are forged nearly in the same way; the palms are welded on to the arms, and then the arms welded on to the shank, and the shackle is rivetted on to the shank, the anchor then being complete.

The following is a more particular account of the operations of the anchor-smith on a large scale. The hearth AA of the anchor-smith's forge, see fig. 6, Plate XXXVIII., is built of brick-work raised about 6 or 9 inches above the ground, and 6 or 7 feet square; in the centre is a large cavity to contain the fire; at the back of the hearth a vertical brick wall B is erected, supporting and forming one side of the chimney, which is little more than a dome placed over the hearth, and opening at the top with a low chimney to carry off the smoke. Behind the wall the bellows CD are placed; the noses of the pipes being about the level of the hearth, and coming through the wall, which at that part is defended from the action of the fire by a facing of fire-stone. In this fire-stone the tue-iron is fixed; it is a tube made of wrought iron, and very thick in the substance, that it may not burn away in the fire: the pipes of the bellows are inserted in the tue-iron, and thus convey the stream of air into the centre of the fire.

The bellows are not like those which ordinary smiths make use of; but two large pairs of single bellows CD are placed horizontally by the side of each other, the pipes of both being inserted into the same tue-iron, and directed to blow to the same focus in the centre of the fire: these bellows are exactly like those in use for domestic purposes, which only throw out air when the upper board is pressed down. The two are worked alternately by means of chains *c d* attached to the ends of the upper boards, and united to the end of the working levers HI, placed over each pair of bellows. From the opposite extremities of these levers other chains *e f* are extended to the opposite side of a long lever GG, which moves upon the pivots of a vertical axis E, and is loaded at the ends by heavy weights, to give it *momentum*. Now, two or more men pushing in opposite directions can give it a motion backwards and forwards, and by the communication of the chains and upper levers HI, they will alternately lift up the upper boards CD of the bellows, which being sufficiently loaded, will subside themselves, and force their con-

tents of air into the fire. The men who work the lever G are aided by six or eight more, who place themselves upon the board of one pair of bellows, and as soon as it subsides, they step upon the other pair, which also sinks, and then they return: they have ropes suspended from the roof to enable them to lift themselves, and mount from one bellows upon the other with more ease. The common tue-iron, which is simply a cone of wrought-iron, set with clay into fire-stone, composing the back of the hearth, is very soon burnt by the great heat. The most improved forges, therefore, are now furnished with what is called the water tue-iron, which is made hollow, and water introduced into it to keep it cool. For this purpose two cones are formed of thick iron plate, each with a small aperture at the vertex; these, when put one into the other, are welded together at their bases and their points, so as to form one cone, which is hollow, with a small space all round; two pipes communicate with the hollow, one bringing a continual supply of cold water, and the other conveying away that which is heated by the fire. By this means the tue-iron is kept cool, and can never acquire such a degree of heat as to be burned away: this tue-iron is set with fire-clay into a frame of cast-iron, built up in the brick-work of the wall B.

The anvil K is only a cubic block of cast-iron, placed on the ground much lower than the ordinary smith's anvil; because, as the anchor-smiths always strike by swinging their hammers over their heads, at arms' length, they have more force when the work lies low on the ground than if raised up. At a distance of eight or nine feet from the hearth AA a strong crane-gib LM is erected, so as to turn freely upon the vertical post M. It has no tackle, but the upper beam L, which must be horizontal, has a large iron loop *n* hung upon it, with a roller *o*, which admits it to run freely backwards and forwards upon the beam: the lower end of the loop suspends the anchor; therefore, by moving the rollers along the beam of the gib, and by turning the gib round on its pivots, the anchor can be placed in any position in the fire or upon the anvil. To give motion to the roller *o*, a rack *p* is connected with it; and this is moved by a pinion upon the axis of the wheel *t*, which has an endless rope hanging down, so that a labourer can reach it, and thus remove the anchor nearer or farther from the centre, however great its weight may be. The workmen employ scarcely any other tools than their sledge-hammers, and a few large punches, cutting chisels, and sets or prints, which, when urged by the hammers, will give any particular figure to the work: the hammers are of the largest kind, and weigh from 14 to 18 pounds, according to the strength of the workmen. In the Royal dockyard great use is made of a stamping machine, which the workmen call *Hercules*, and which is very similar to the machine for driving piles. A heavy iron weight N, guided like the ram of the pile engine, is drawn up by the strength of several men, and let fall upon the anchor, to weld the bars, in the same manner as by a forge-hammer. The machine is erected on a large block of stone, which supports the anvil O: two square iron bars PP are fixed on each side of the anvil, in a vertical position, the angles of the bars being placed towards each other. These vertical bars are eight or nine feet high, and are fixed at the top to a beam in the roof of the building in which the machine is placed. The ram N, which weighs $4\frac{1}{2}$ cwt., is fitted to slide up and down between the bars P, having notches in its sides, which receive the angles of the bars: it is drawn up by a rope passing over an iron pulley Q, mounted upon pivots above the top of the vertical bars; and the rope has eight or ten small ones R spliced into it, for as many men to act together (which they do by a motion similar to that of ringing), to elevate the ram, and let it fall upon the iron placed upon the anvil O. The Hercules is placed in the same sweep of the crane as the anvil K, so that the iron can be conveyed to either with equal ease.

The first step in making the different parts of the anchor is to assemble or faggot the bars. For the centre of the mass which is to make the shank, four large bars are first laid together; then upon the flat sides of the square so formed smaller bars are arranged, to make it up to a circle. The number is various, but in large anchors six or eight bars are laid on every side. This circle is surrounded by a number of bars arranged like the staves of a cask; as many as 36 are often used, and they form a complete case for the others. The ends are made up by short bars to a square figure. The faggot is finished by driving iron hoops upon it at sufficient distances; see W in the figure; and it is suspended from the crane in such a manner that it can be moved and turned in any direction, by only one or two men, even when it weighs three tons. For this purpose an iron pulley *k* is hooked to the iron loop *n* of the crane; and a short endless chain *l* passed over the pulley suspends the faggot in its loop. In this manner the weight of the iron is in reality borne by the pivot of the pulley *k*, and the mass can be easily turned round upon its centre to bring any side upwards. To give a power to the man who guides it, one of the four central bars is double the length of the faggot, and projects, see *g*, to form a long lever, by which it is steered; and two holes are made through the end of this bar to insert a cross lever *h*, by which the faggot is turned or rolled round upon its centre. As the faggot hangs very nearly on a balance in the loop of the chain *l*, the man, by weighing on the end of the long bar *g*, can easily raise up its end from the anvil K, and, swinging the crane on its pivots, move it into the fire, which is made up hollow like an oven. To effect this form, the fireman first spreads the coals evenly upon the hearth, and with his shovel or slice makes a flat surface about the level of the tue-hole: he then arranges some large cinders or cakes round in a circle upon this surface, and by other cinders builds it up like an oven or dome, leaving a mouth to introduce the iron. The oven is adapted in size to the magnitude of the mass of iron, and must be brought forwards upon the hearth, to leave a space between its interior cavity and the orifice of the tue-iron; in which space a passage is made from the tue-hole to the fire, and filled up with large lighted coals, and then covered up by small coals. The blast from the bellows passes through these hot coals, in order that the cold air may not enter the fire at once and blow on the iron, but be first converted into flame, which is urged forcibly into the oven, and reverberated from the roof and sides upon the iron placed in the centre. As the floor of the oven is nearly upon a level with the tue-hole, the flame from the coals between it and the fire also plays upon the bottom, and thus heats the iron on all sides. The outside of the dome is covered over with a considerable thickness of small coals, which cake together, and, as the inside of the oven consumes, settle down into a dome again, which the smith aids by striking the outside with the flat of his slice. If the fire breaks out at any place in the roof, the smith immediately repairs the breach with fresh coals, and damps them with water, that they may not burn too fast; for if the inside of the oven burns very fiercely, the flames will not be reverberated so forcibly as when it is in the state of burning cake. Care must likewise be taken to prevent the fire from burning back to the tue-iron. The mouth of the oven should be made no larger than to admit the work; and, that as little heat as possible may escape by the iron, the mouth is filled round it with coals. F is an iron screen hung on hinges, to swing before the mouth of the fire when the iron is withdrawn, that the workmen may not be scorched by the heat.

Anchor.

All the men unite to assist in blowing the bellows, which they work in the manner already described, from half an hour to an hour, according to the size of the anchor, until they have raised the iron to a good welding heat. The mouth of the fire is opened occasionally to inspect the process, and the faggot is turned in the fire if it is not found to be heating equally in every part. Eight men, and sometimes more, are employed to forge an anchor: six of them strike with the hammers, one is stationed at the guide-bar, and the eighth, who is master or foreman, directs the others, and occasionally assists to guide the anchor. When the whole of that part which is in the fire comes to a good welding heat, the workmen leave the bellows and take up their hammers; the coals are removed from the iron, which is swung out of the fire by the man who guides it, assisted by others, and the hot end placed on the anvil; during which time one or two labourers with birch brooms sweep off the coals which adhere to it.

The smiths now begin hammering, one half the number standing on one side, and the other half on the other: they use large sledges weighing from sixteen to eighteen pounds, and faced with steel, striking in regular order, one after the other, swinging the hammers at arms' length, and all striking nearly at the same place. The foreman places himself near the man who guides, and with a long wand points out the part he wishes them to strike, and at the same time directs and sometimes assists the guide to turn the faggot round, so as to bring that side uppermost which requires to be hammered. This is continued as long as the metal retains sufficient heat for welding. This process is exceedingly laborious for the workmen, and is much more effectually performed by means of the Hercules, which strikes such powerful blows upon the iron as to consolidate the bars much more than the strokes of small hammers can do, however long they may be continued. The iron is now returned to the fire, another mouth being opened on the opposite side of the oven, to admit the end or part which has been welded to come through, that a part farther up the faggot may be heated; and when this is done the welding is performed in the same manner as before. Thus, by repeated heatings, the faggot is made into one solid bar of the size and length intended. It is then hammered over again at welding heats to finish it, and make an even surface; and in this second operation the workmen do not leave off hammering as soon as the iron loses its full welding heat, but continue till it turns almost black. This renders the surface solid and hard, and closes all small pores at which the sea-water might enter, and by corroding the bars, expand them, and in time split open the mass of iron.

The shank for an anchor is made larger at the lower end, where the arms are to be welded to it, and is of a square figure. A sort of rebate or scarf, *s*, is here formed on each side of the square, in order that the arms may apply more properly for welding. This scarf is made in the original shape of the faggot, and finished by cutting away some of the metal with chisels whilst it is hot, and using sets or punches, properly formed, to make a square angle to the shoulder of the scarf. The upper end of the shank is likewise square; and the length between these square parts is worked either to an octagon or round, tapering regularly from the lower to the upper end. The hole to receive the ring of the anchor is pierced through the square part at the upper end, first by a small punch, and then larger ones are used till it is sufficiently enlarged. The punch is made of steel; and when it is observed to change colour by the heat, it is struck on the opposite end to drive it out, and is instantly dipped in water to cool it, and another driven in. The projecting pieces or nuts, which are to keep the stock or wooden beam of the anchor, and its place on the shank, are next welded on. To do this the shank is heated, and at the same time a thick bar is heated in another forge: the end of this is laid across the shank, and the men hammer it down to weld it to the shank; then the piece is cut off by the chisel, and another piece welded on the opposite side.

Whilst this process of forging the shank is going on, the smiths of another forge, placed as near as convenient to the former, are employed in making the arms, which are made from faggots in the same manner as the shank, but of less size and shorter, they are made taper (see X), one end of each being smaller than the other: the larger ends are made square, and cut down with scarfs, *r*, to correspond with those, *s*, at the lower end of the shank. The middle parts of the arms are rounded, and the outer extremities are cut away as much as the thickness of the flukes or palms *m*, that the palms may be flush with the upper sides when they are welded on. The flukes are generally made at the iron-forges in the country, by the forge-hammer; but in some yards they are made by faggoting small bars, leaving a long one for a handle. When finished, they are welded to the arms, which have then the appearance of X. The next business is to unite the arms to the end of the shank; and in doing this particular care is necessary, as the goodness of the anchor is entirely dependent upon its being effectually performed. In so large a weld, the outside is very liable to be welded, and make a good appearance, while the middle part is not united. To guard against this, both surfaces of the scarfs should be rather convex, that they may be certain to touch in the middle first. When the other arm is welded, the anchor is complete, except the ring, which is made from several small bars welded together and drawn out into a round rod, then bent to a circle, put through the hole in the shank, and its ends welded together. If the shank or other part is crooked, it is set right by heating it in the crooked part, and striking it over the anvil, or by the Hercules. After all this the whole is heated, but not to a white heat, and the anchor hammered in every part, to finish and make its surface even. This is done by lighter hammers, worked by both hands, but not swung over the head. This operation renders the surface of the metal hard and smooth; and if very effectually performed, the anchor will not rust materially by the action of the sea-water.

The iron from which anchors are made ought to be of the best quality: that kind of it which is called red short will not bear sufficient hammering to weld the bars; and cold short, from its brittleness, is not to be depended upon when the anchor is in use. A good anchor should be formed of the toughest iron that can be procured.

The most extensive establishment for fabricating anchors, &c., is that at Woolwich dockyard, where the Admiralty anchors are made. There the blowing apparatus, the working of the lift and tilt hammers, &c., is all done by a steam-engine of from 14 to 16 horse power. (J. A.)

To steer the ship to her Anchor, is to steer the ship's head towards the place where the anchor lies when they are heaving in the cable, or laying in a strong tideway, that the cable may thereby enter the hause with less resistance, and the ship advance towards the anchor with greater facility. Ships often prevent collision by attention to the helm.

Anchor Ground is a bottom which is neither too deep, too shallow, nor rocky; as in the first the cable bears too nearly perpendicular, and is thereby apt to jerk the anchor out of the ground; in the second, the ship's bottom is apt to strike at low water, or when the sea runs high, by which she is exposed to the danger of sinking; and in the third, the anchor is liable to hood the broken and pointed ends of rocks, and tear away its flukes, whilst the cable, from the

same cause, is constantly in danger of being cut through as it rubs on their edges.

Anchor, in *Architecture*, is a sort of carving somewhat resembling an anchor. It is commonly placed as part of the enrichment of the boultins of capitals of the Tuscan, Doric, and Ionic orders, and also of the boultins of bed mouldings of the Doric, Ionic, and Corinthian cornices, anchors and eggs being carved alternately through the whole buildings.

ANCHUSA, a genus of plants of the natural order of *Boragineæ*. The most noted are *A. officinalis*, once used in medicine as a demulcent, and *A. tinctoria*, or *alkanet*, indigenous in the south of Europe, with a root that yields a fine red to alcohol, wax, and all sorts of oils.

ANCHYLOSIS or Ancylosis (ἀγκύλος), a term in surgery, implying an immovable state of a joint arising from disease.

ANCIENT Demesne, in *English Law*, is a tenure whereby all manors belonging to the crown in the times of William the Conqueror and St Edward were held. The numbers, names, &c., were entered by the Conqueror in the record called *Doomsday Book;* so that such lands as by that book appeared to have belonged to the crown at that time are called *ancient demesne*.

ANCIENTY, in some ancient statutes, is used for eldership or seniority. The elder sister can demand no more than her other sisters, beside the chief mesne, by reason of her ancienty. This word is used in the statute of Ireland, 14th Henry III.

ANCILE, in *Antiquity*, a shield believed to have fallen from heaven, in the reign of Numa Pompilius; at which time, likewise, a voice was heard declaring that Rome should be mistress of the world as long as she should preserve this holy buckler. It was kept with great care in the temple of Mars, under the direction of 12 priests; and, lest any should attempt to steal it, 11 others were made so like as not to be distinguished from the sacred one. These ancilia were carried in procession every year round the city of Rome.

ANCILLARIA, or Ancilla, a Lamarckian genus of minute univalve marine shells, allied to *Olivæ*. See Conchology.

ANCILLON, Johann Peter Friederich, a celebrated historian, and one of the most distinguished members of the Royal Academy of Sciences of Prussia, was born at Berlin in 1766, and died in that city, after a short illness, on the 19th April 1837. His theological studies were commenced at Berlin, and completed at Geneva; and soon after he visited Paris, about the commencement of the revolution, when he became acquainted with Mirabeau. On his return to Berlin he was appointed professor of history in the Royal Military Academy, and a minister of the Reformed Church, in which latter capacity he speedily became distinguished for the eloquence of his style. In 1806 was published his *Tableau des Revolutions*, or a sketch of the revolutions of the political system of Europe from the close of the fifteenth century to the eighteenth, which is perhaps the ablest and most philosophical work on that subject that has appeared. The merits of Ancillon were not overlooked. He was appointed tutor to the Prince Royal of Prussia, and received various appointments from the government. In 1814 he attended his royal pupil to Paris, where he became acquainted with MM. Guizot and De Broglie, and other persons of eminence. He was also much employed by his government in diplomatic affairs, and was made a counsellor of state. His other writings are as follows: *Melanges de Littérature et de Philosophie; Essais Philosophique, &c.; Essais de Philosophie, de Politique, et de Littérature; Sermons, &c.* See Preliminary Dissertation, No. I. of this work.

ANCLAM. See Anklam.

ANCONA, a maritime city of Italy, in the States of the Church, and capital of a delegation of the same name. It is pleasantly situated on the shores of the Adriatic, occupying a slope between two hills, on one of which stands a cathedral, and on the other a citadel; but the streets are generally narrow and irregular. It possesses some fine buildings, such as the exchange, town-house, and lazaretto; is the seat of a bishop, has a court of appeal, and a public library of nearly 10,000 volumes. Its port, which is the best on the Adriatic, is defended by several forts, and protected by two moles. A magnificent triumphal arch of white marble adorns the ancient mole. It was erected in honour of the emperor Trajan, who greatly embellished the city, and built this mole. An arch, dedicated to pope Benedict XIV. decorates the new mole, which has at its extremity a lighthouse with a revolving light. The principal manufactures of Ancona are silk, sail-cloth, paper, leather, and wax candles; the exports are corn, wool, wax, bacon, and tallow; and the imports consist of colonial goods, drugs, and metals. Ancona has been a free port since 1732. The number of vessels that entered its port in 1842 was 1522, with an aggregate burthen of 109,813 tons. It has communication by steam with Trieste, Corfu, Patras, Syra, Athens, Smyrna, Constantinople, and Alexandria. Pop. 32,000, including many Greeks, and about 5000 Jews. Long. 13. 30. 35. E. Lat 43. 37. 42. N.

This city was founded about 380 B. C. by Greek colonists, who had fled from Syracuse to escape the tyranny of the elder Dionysius. It rose rapidly into importance, and became celebrated for its purple dye. The exact time of its subjection to the Romans is uncertain; but it was taken possession of by Cæsar immediately after he crossed the Rubicon. Of its celebrated temple of Venus no traces remain, but it is supposed to have occupied the site of the present cathedral. In the middle ages it was an independent republic, and continued such until 1530, when Pope Clement VII. took possession of the town, and built the citadel under the pretext of defending it against the Turks. In 1798 Ancona was taken by the French, and in the following year it surrendered to the combined forces of the Austrians, Russians, and Turks, after a long and gallant resistance, under the direction of General Meunier. The French captured it a second time in 1801; but in the following year restored it to the Pope.

It afterwards formed part of the kingdom of Italy, till 1814, when it was again united to the papal dominions. In 1832 a party of French landed unexpectedly and took possession of the citadel, which they refused to evacuate so long as any Austrian troops remained within the Papal States: and this demand having been complied with, the French troops withdrew in 1838.

ANCOURT, Florent Carton d', an eminent French comic writer and actor, was born at Fontainbleau, on the 1st November 1661. He died on the 6th December 1726, being 65 years of age. The plays which he wrote were all, with one exception, comic. They have been frequently reprinted, and form, in the best edition, namely, that of 1760, a collection of 12 vols. 12mo.

ANCUS Marcius, the fourth king of the Romans, succeeded Tullus Hostilius 640 years before Christ. He defeated the Latins, subdued the Fidenates, conquered the Sabines, Volsci, and Veientines, enlarged Rome by joining to it Mount Janiculum, and made the harbour of Ostia. He died about 617 years before the Christian era. In his reign many of the conquered Latins were incorporated with the Roman state, and not receiving the full franchise, formed the first elements of the Roman plebs.

ANCYLOBLEPHARON (from ἀγκύλος, *bent*, and βλέφαρον, *an eyelid*), a disease of the eye, which closes the eyelid.

ANCYLOGLOSSUM (from ἀγκύλος, *crooked*, and γλῶσσα *the tongue*), a contraction of the ligaments of the tongue. Some have this imperfection from their birth, others from some disease. In the first case, the membrane which supports the tongue is too short or too hard; in the latter, an ulcer under the tongue, healing and forming a cicatrix, is sometimes the cause. These speak with some difficulty. Those who have this imperfection by nature are late in acquiring the power of speech; but having acquired it, they soon speak properly. Such persons are commonly called *tongue-tied*.

ANCYRA. See ANGORA.

ANDALUCIA, an extensive region in the south of Spain, on the Mediterranean Sea. It is divided into eight provinces, viz., Almeria, Granada, Jaen, Malaga, Cadiz, Cordova, Huelva, and Sevilla. Though its surface is very unequal, and its soil and climate vary with the elevations of the land, it must be considered the most rich and delightful of all the divisions of the peninsula.

The geographical denomination should strictly be confined to the ancient kingdoms of Sevilla and Cordova, divided into High and Low Andalucia; but the name is now generally extended so as to include also the kingdoms of Jaen and Granada. This will comprehend all the beautiful and picturesque south of Spain, from Lat. 30. 42. to Lat. 36. N., and between Long. 1. 45. and Long. 7. 15. W. It is bounded on the north by the chain of the Sierra Morena; on the east by the Sierras of Segura and Cazorla, and partly by the Mediterranean; on the south by the Mediterranean, the Straits of Gibraltar, and the Atlantic; and on the west by Portugal. Its area is computed at 3283 square leagues. It is divided into numerous valleys of varied extent by mountain arms that traverse it in many directions. Some of these are shaggy with wood, others are denuded of vegetation, while some of the loftier mountains are partially covered with perennial snow, which is a luxury highly prized by the inhabitants during their fervid summers. On many occasions we have found the heat in the shade ranging from 86° to 96° Fahr.; but this temperature is abated by refreshing sea breezes along its extensive coasts. The winter is so mild that the nightingale continues its song in the groves throughout the year, and if ever a flake of snow descends on the plains, it melts almost on touching the ground. Many of the less elevated mountains are clothed with vines, which produce an abundant supply of delicious wines; or they are covered with excellent pasture.

In the bowels of the mountains the Carthaginians and the Romans sought for silver, and found gold in some of the streams. Valuable mines of argentiferous galena, and some copper ores are now wrought; and no country abounds more in beautiful marbles and serpentines. These are much used in the decorations of the churches.

The principal river of Andalucia is the Guadalquiver, with its numerous affluents. It rises in the Mountains of Jaen on the confines of Murcia, and traverses Andalucia in a south-west direction, passing by the cities of Andujar, Cordova, Palma, and Sevilla, and falls into the sea at San Lucar.

Its principal affluents have various names, as the Rio Huelva, Rio Biar, and Rio Guadiato, from the north-west; from the south-east the Darro and the Genil, which water the lovely *Vega* or plain of Granada; while the Rio Gaudix, Rio Guardal, Rio Guadalimar, and Rio Corbones, flow into the Guadalquiver in other directions. Besides these, the noble stream of the Guadiana washes a part of its western frontier.

The minor rivers of this fine province that flow directly into the sea are as follows, commencing on the west side: the Rio Tinto, falling into the sea at Huesca; Rio Guadalete, at Santa Maria; Rio Barbate, into the Bay of Trafalgar; Rio Guadranque, into the Bay of Gibraltar; Rio Verde, near Marbella; Rio Guadaljore, near Malaga; Rio Guadalpo, at Motril; Rio Adra, Rio Almeria, and Rio Almanzora, falling into the Mediterranean.

The mountains in Andalucia are the Sierra Bermeja and its branches, which, with Sierra Blanquilla, constitute part of the larger sierras of Ronda, Filabres, Bujo, Javal, Cohol; the sierras of Leita, Quesada, and Torres in Jaen, which unite with the Sierra Morena and Sierra Segura; the sierras of the Alpujarras, between the Sierra Nevada and the Sierra of Gador, with the sierras of Contraviesa, and Cazorla; Susiana and Constantina.

When the traveller descends from the table-land of New Castile into Andalucia, he suddenly feels that he has entered a very different climate. The temperature of the air, the total change in vegetable forms, almost indicate a tropical region, especially as he approaches the coast. The more common European plants there give place to the wild olive, the caper bush, the aloe (*agave*), the cactus, the evergreen oak, and fragrant groves of orange and lemon trees; while the place of furze and heaths is supplied by the astragalus lignosus, and the prickly palmated leaves of chamærops humilis; and in a few places he may behold the graceful form of the date-palm depicted on a sky of the serenest blue. On the coasts of the Mediterranean, about Marbella and Malaga, the sugar-cane is successfully cultivated; and no inconsiderable quantity of silk is produced in the same regions. The sides of the hills are often covered with extensive vineyards; and the ill-cultivated and generally uninclosed plains wave with luxuriant crops of wheat, or are green with immense fields of melons cultivated with the plough. The horses and bulls of Andalucia are celebrated all over Spain; sheep and swine are extensively bred, and game is abundant.

The general statistics of Andalucia will be best seen by reference to the two adjoined tables, drawn up by Don Pascual Madoz, for his *Diccionario Geografico-Estadistico-Historico de España*, a valuable and laborious work published at Madrid in 1847.

By this table the population of all Andalucia amounts to 2,305,950: the "ratable riches" to about L.3,706,000 sterling, and the contributions levied on it to L.933,000.

The natives of Andalucia are a lively people, given to pleasure, and of a very ardent imagination, superstitious, boastful, and unwarlike, but ready-witted and good-humoured. Their forms are not tall, but they are vigorous and well-made, generally with jet black hair, dark eyes, and a skin less fair than the natives of Aragon and the north of Spain. The women are considered as the handsomest in all the peninsula, with most brilliant eyes, and very graceful figures. The dialect spoken in Andalucia is said by Castilians to retain something of the Arabesque, in the use of certain words that are not reckoned pure *Castilian* or Spanish, and in a greater profusion of gutturals than is used in the central provinces; circumstances not to be wondered at, when we reflect that for seven centuries the Arabians were the dominant race in Andalucia.

The original population of this region is supposed to have been from Mauritania. We know that its advantageous position for commerce, its general products, and its mines, early attracted the adventurous merchants of Tyre and Carthage to its shores; and it became an important possession to the Phœnicians and Carthaginians until it was wrested from the latter by the Romans. Before that period it had many flourishing cities; as Gades, Emerita, Hispalis, Corduba, Malaca, and Carteia. From the Romans it passed successively to the Visigoths, the Arabs, and the present Spanish race.

For the civil history of this province, see SPAIN.

Table of the Captain-Generalships, Audiencias, Provinces, Judicatories, Municipal Councils, Population, Electoral Bodies, Army Recruits, &c., in Andalucia.

Capitanias Generales.	Audiencias.	Provinces.	Judicatories.	Municipalities.	Population. Families.	Population. Persons.	Electors.	Eligible.	Army Recruits.	Proportion drawn out of 25,000.	Rateable wealth in Reales Vellon.	Contributions paid in Reales Vellon.
Granada....	Granada	Almeria	9	103	63,216	252,952	25,549	23,847	13,893	492	35,206,923	4,762,749
		Granada	13	205	81,681	370,974	37,738	37,666	21,637	790	41,382,138	8,214,369
		Jaen......	12	98	64,959	246,639	27,913	25,469	14,471	570	25,210,634	10,697,539
		Malaga..	13	110	86,186	338,442	33,067	29,369	19,437	701	66,833,019	11,598,837
			47	516	296,042	1,209,007	124,267	116,341	69,439	2553	168,632,714	35,273,494
Andalucia	Sevilla...	Cadiz....	12	40	68,660	286,316	19,522	18,276	18,121	645	38,759,322	18,774,206
		Cordova.	15	77	76,690	306,760	28,740	26,100	16,100	674	70,799,492	11,786,657
		Huelva..	16	78	34,520	136,564	16,817	15,762	8,657	261	20,033,644	2,970,457
		Sevilla...	10	97	7,685	367,303	31,603	24,995	20,258	769	58,581,126	20,732,279
			49	292	267,555	1,096,943	96,682	85,135	63,136	2349	188,173,584	54,263,599
		Total....	96	808	563,597	2,305,950	220,949	201,474	132,574	4902	356,806,298	89,537,093

Maritime Statistics of Andalucia, including the Canaries, as to Foreign Trade, of which Cadiz is the centre, divided between the Provinces and Departments of—

			Pilots.	Officials.	Captains.	Superannuated.	Mariners. Able-bodied.	Mariners. Ordinary.	Strangers employed.	Carpenters. Skilful.	Carpenters. Ordinary.
Cadiz........ Motril....... San Lucar	Algeciras... Almeria.... Huelva.....	Malaga...... Sevilla and Canaries....	618	237	1291	35	3318	1714	4499	2135	373

ANDAMAN Islands. These islands, which are situated on the eastern side of the Bay of Bengal, are a continuation of the archipelago which extends from Cape Negrais to Atchein Head, stretching from Lat. 10. 32. to 13. 40. N., and from Long. 90. 6. to 92. 59. E. They are called the Great and the Little Andaman. The Great Andaman, which is the northernmost, is 140 miles in length, and only 20 in breadth. It was formerly supposed to be one island; but two straits have been discovered, which open a clear passage into the Bay of Bengal, and divide the Great Andaman into three islands. The Little Andaman, which lies 30 miles south of the Great Andaman, is 28 miles long and 17 broad. It does not afford any good harbour, though tolerably safe anchorage may be found near its shores. These islands have an extremely moist temperature. They are situated in the direct current of the south-west monsoon; and the central mountains, some of the lofty peaks of which, as Saddle Peak in the Large Andaman, rise to the height of 2400 feet, intercept the clouds, which, for about eight months in the year, pour down incessant torrents of rain on the plains below. According to a meteorological table kept by an officer resident on the island, 98 inches of water appear to have fallen in the course of seven months. On the whole, however, the temperature is milder than in Bengal, and the heat not so intolerable.

The island is totally uncultivated, and the savage inhabitants glean a miserable subsistence from the spontaneous produce of the woods, in which the researches of the Europeans have hitherto found little that is either palatable or nutritious. The principal trees are the banyan-tree, the almond-tree, the oil-tree, which grows to a great height and yields a very useful oil; the poon, the dammer, the red wood, which for furniture is little inferior to fine mahogany; the ebony, the cotton-tree, the soondry, chingry, and beady; the Alexandrian laurel, the poplar, a tree resembling satin-wood, bamboos, cutch, the melon, aloes; the iron-tree of stupendous size, whose timber almost bids defiance to the axe of the wood-cutter. There are many other trees well adapted for the construction of ships; and, as in all the equatorial forests, there are numberless creepers and ratans, which surround the stems of the trees, and are so firmly interlaced together, that the forests are impervious, except a road be previously cut through them.

The only quadrupeds seen on the island are hogs, rats, and the ichneumon; also the iguana of the lizard tribe; all which are very destructive to poultry. There are several species of snakes and scorpions, by which the labourers employed by the British in clearing away the underwood were frequently stung; but in no instance did the sting prove mortal. The patient was frequently affected with violent convulsions, which gradually yielded to the operation of opium and eau-de-luce.

Fish abound on the shores, and are caught in great numbers during the prevalence of the north-east monsoon, when the weather is mild: gray mullet, rock cod, skate, and soles, are among the best. There are, besides, various other species, such as guanas, sardinas, roe-balls, sable, shad, prawns, shrimps, cray-fish, a species of whale, and sharks of an enormous size. Shell-fish are in great plenty, and oysters of an excellent quality. The shores abound in a variety of beautiful

shells, such as gorgonias, madreporas, murex, and cowries, with many other sorts equally beautiful.

Birds are not numerous, and they are extremely shy. Doves, parroquets, and the Indian crow, are the most common. Hawks from the neighbouring continent are sometimes seen hovering over the tops of trees; and a few aquatic birds, such as the king-fisher, a sort of curlew, and the small sea-gull, frequent the shores. Within the caverns and recesses of the rocks are found the edible birds' nests so highly prized among the Chinese, and now occasionally brought into Britain.

The whole population of the islands does not exceed 2000 or 2500, and they are probably the most uncivilised people on the face of the globe. They are far below the ordinary scale of barbarism; and in their modes of subsistence, and in their dwellings, they rise very little above the brute creation. They wear no clothes, and seem insensible to any feeling of shame from the exposure of their persons. The woods supply them with little in the way of food. They are provided with no pot or vessel that can bear the action of fire, and they cannot therefore derive much advantage from such esculent herbs as the forests may contain. The cocoa-nut, which thrives so well in the neighbouring islands, is not found in the Andamans, though the natives are extremely fond of it. The fruit of the mangrove is principally used by them. Their principal food consists of fish, in quest of a precarious meal of which they climb over the rocks, or rove along the margin of the sea, often without success during the tempestuous season; but they eagerly seize on whatever else presents itself, such as lizards, iguanas, rats, and snakes. Their diseased and extenuated figures sufficiently testify that they have no abundant or wholesome nourishment. In stature the inhabitants of the Great Andaman seldom exceed five feet; their limbs are disproportionably slender, their bellies protuberant, their shoulders high, and heads large; and, what is singular and unaccountable, they have all the characteristic marks of a degenerate race of negroes, with woolly hair, flat noses, and thick lips; their eyes are small and red, their skin of a deep sooty black, while their countenances exhibit a mixed expression of famine and ferocity. Lieutenant Alexander describes the inhabitants of Little Andaman as far from being a puny race. When he landed in a boat he counted sixteen strong and able-bodied men, many of them very vigorous. The ingenuity of these savages is principally seen in the fabrication of a few simple weapons on which they depend for their subsistence. These are a bow from four to five feet long, with arrows of reed, headed with fish bone or wood hardened in the fire, a spear of heavy wood sharply pointed, and a shield made of bark. With these implements they shoot and spear the fish, which abound in their bays and creeks, with surprising dexterity. The settlement of these islands, with their negro inhabitants, so widely different in their appearance not only from all those of the Asiatic continent, in which the Andamans are embayed, but also from the natives of the Nicobar islands, presents a curious problem, which has never been satisfactorily explained. It is supposed, however, by Symes, that the original stock must have been settled on the island by the accidental shipwreck of some Arab slave-ship. The English made a settlement on the larger Andaman in the year 1793. Their object was to procure a commodious harbour on the east side of the Bay of Bengal, to receive and shelter ships of war during the continuance of the north-east monsoon; also to provide a place of reception for convicts sentenced to transportation from Bengal. But the settlement, proving unhealthy, was abandoned in 1796. These islands, together with the Nicobar and other smaller islands, were included by Ptolemy in the general appellation of *Insulæ Bonæ Fortunæ*, and were supposed by him to be inhabited by a race of anthropophagi, though there are no proofs of the modern inhabitants being addicted to cannibalism. (Symes' *Embassy to Ava;* Alexander's *Travels from India to England, comprehending a Visit to the Burman Empire, &c.;* Hamilton's *Gazetteer.*) (D.B—N.)

ANDANTE, in *Music*, signifies a movement moderately slow, between *largo* and *allegro.*

ANDEGAVI, a Gallic tribe, whose chief town was Juliomagus, now Angers.

ANDELYS, LES, an arrondissement in the department of the Eure, in France. It extends over 392 square miles, or 250,840 acres, is divided into six cantons, which are subdivided into 134 communes, and in 1851 contained 64,717 inhabitants. The chief town, of the same name, had 5069 inhabitants. It is four miles from the Paris and Rouen Railway. The manufactures are fine cloths, cotton, bonnets, &c.

ANDENA, in *Old Writings*, denotes the swath made in the mowing of hay, or as much ground as a man could stride over at once.

ANDENNE, a town of Belgium, capital of a canton of the same name, arrondissement and province of Namur, on the right bank of the Meuse, ten miles east of Namur. It is famous for its manufactures of porcelain and tobacco-pipes. In the neighbourhood are beds of pipe-clay, quarries of marble, and mines of iron and lead. Pop. in 1850, 5316.

ANDERAVIA. See INDERABIA.

ANDERNACH (the ancient *Antunacum*), a town in the Prussian province of the Lower Rhine and district of Coblenz, ten miles north-west of that town. It is situated on the Rhine, and was once strongly fortified, but its walls are now in ruins. It has tin and leather works; and exports mill-stones and pounded tufa, used as a cement, which hardens under water, and is much used by the Dutch in constructing their dikes. Pop. in 1849, 3785. Long. 7. 4. E. Lat. 50. 57. N.

ANDERSON, ADAM, was born in Scotland in 1692. He was a clerk for forty years in the South Sea House in London, where he published a large work entitled *Historical and Chronological Deduction of the Origin of Commerce, containing a History of the Great Commercial Interests of the British Empire,* &c., which is voluminous and heavy; but he seems to have anticipated in some of his speculations the opinions of later times. It was first published in 1762, in two vols. fol. A third edition appeared in 1797–9, in four vols. 4to, the last volume being an appendix and continuation by the editor, Mr Walton. Anderson died in 1765.

ANDERSON, *Alexander*, a very eminent mathematician, who flourished in the early part of the seventeenth century. He was born at Aberdeen, but passed over to the Continent, and settled as a private teacher or professor of mathematics at Paris, where he published or edited, between the years 1612 and 1619, various geometrical and algebraical tracts, which are conspicuous for their ingenuity and elegance. It is doubtful whether he was ever acquainted with the famous Vieta, master of requests at Paris, who died in 1603; but his pure taste and skill in mathematical investigation had pointed him out to the executors as the person most proper for revising and publishing the valuable manuscripts of that illustrious man, who had found leisure, in the intervals of a laborious profession, to cultivate and extend the ancient geometry, and, by adopting a system of general symbols, to lay the foundation and begin the superstructure of algebraical science. Anderson did not come forward, however, as a mere editor; he enriched the texts with learned comments, and gave neat demonstrations of those propositions which had been left imperfect. He afterwards produced a specimen of the application of geometrical analysis, which is distinguished by its clearness and classic elegance.

Of the time of this able geometer's birth and death we are ignorant. His brother David Anderson, a small proprietor in Aberdeenshire, but engaged in business, had likewise a strong turn for mathematics and mechanics, which, joined to great versatility of talent, made him be regarded by his neighbours at that period as a sort of oracle. The daughter of this clever and active burgess was married to John Gregory, minister of Drumoak, in that county, father to the celebrated James Gregory, inventor of the reflecting telescope; and is supposed to have com-

municated to her children that taste for mathematical learning which afterwards shone forth so remarkably in the family of the Gregorys.

The works of Anderson amount to six thin 4to volumes, which are now very scarce. (J. L.)

ANDERSON, *Sir Edmund*, a younger son of an ancient Scottish family settled in Lincolnshire. He was some time a student of Lincoln College, Oxford, and removed from thence to the Inner Temple, where he applied himself diligently to the study of the law, and became a barrister. In 1582 he was made lord chief-justice of the common pleas, and in the year following was knighted. He held his office to the end of his life in 1605. His works are, 1. Reports of many principal Cases argued and adjudged in the time of Queen Elizabeth in the Common Bench, Lond. 1644, fol.; 2. Resolutions and Judgments on the cases and matter agitated in all courts of Westminster in the latter end of the reign of Queen Elizabeth, Lond. 1655, 4to.

ANDERSON, *James, LL.D.*, was born at the village of Hermiston, in the county of Edinburgh, in the year 1739. His parents were in humble life, and had possessed a farm for some generations, which he was destined to inherit and to cultivate. At an early age he lost his parents: his education, however, was uninterrupted; and conceiving that an acquaintance with chemistry would promote his professional success, he attended a course of lectures on that science, then delivered by Dr Cullen.

Enlarging the sphere of his employments, Anderson forsook his first possession, and rented in Aberdeenshire a farm of 1300 acres, which was then nearly in a state of nature. But previous to this he became known to men of letters, by some essays on planting, which, under the signature "Agricola," he ventured to commit to the world through the medium of the *Edinburgh Weekly Magazine*, in 1771.

After withdrawing from his northern farm, where he resided above 20 years, he settled in the vicinity of Edinburgh. His agricultural speculations were still continued; and when a parliamentary grant was about to be proposed to Mr Elkington for a particular mode of draining land, he reclaimed the discovery as having been made by himself many years anterior. In 1791 Dr Anderson projected a periodical publication called *The Bee*, consisting of miscellaneous original matter, which attained the extent of 18 volumes in octavo. It was published weekly, and a large proportion of it came from his own pen. From this period till 1803 he gave to the world a number of publications chiefly on agricultural subjects, which had no small influence in advancing national improvements. He has the great merit of being the first who satisfactorily unfolded the true theory of rent. He showed by an original and able analysis that rent is not the recompense of the work of nature, nor a consequence of land being made private property, but that it depends on the various degrees of fertility of land, and on the circumstance of its being impossible to apply capital indefinitely to any quality of land, without receiving from it a diminished return.

Dr Anderson remained in his retreat, enjoying the cultivation of his garden; and after a gradual decline, partly occasioned by the over-exertion of the mental energies, he died in the year 1808, aged 69. He was twice married; first, to Miss Seton of Mounie; secondly, to an English lady. By his first marriage he had thirteen children, six of whom survived him. During a period of overstrained political fervour, certain papers formed part of the periodical works already referred to, which were thought to contain a libel on the government. Although Dr Anderson's principles were noted for attachment to the existing administration, he was called upon to give up the author of the obnoxious compositions, which he steadily refused, and, even in the face of the civil magistrates, charged his printers not to violate their fidelity to him and the author in betraying his name. The business terminated here, until a factious individual insinuated to the same magistrates that the compositions had proceeded from one of the supreme judges, whose party politics were avowedly hostile to those of government. Dr Anderson having learned the reproach, hastened to relieve the object of it by divulging the name of the real author, who, to the universal surprise of the public, proved to be none other than the traducer himself.

ANDERSON, *James, W.S.* This learned and indefatigable antiquary was the son of the Rev. Patrick Anderson, one of the many victims whom the tyranny of the government of his country condemned in 1678 to imprisonment on the Bass Rock, for attending a conventicle. This son was born at Edinburgh in August 5. 1662, and was educated to the legal profession, in which he became *Writer to the Royal Signet*, a station in Scotland which may be considered as equivalent to an *Attorney* and *Notary Public*.

His character and acquirements stood so high, that just before the Union the Scottish parliament entrusted him with preparing for publication what remained of the public muniments of the kingdom; and in their last session supplied him with L.1940 sterling for defraying the expenses of that great undertaking. At this work he laboured for many years with great judgment and perseverance; but it was not completed at his death in 1728. The work was published under the care of the celebrated Ruddiman; who in an excellent preface laments the death of his learned countryman, and adds, "tantumque non ad umbilicum produxerat ὁ πάνυ Jacobus Anderson." This work is the great "DIPLOMATA ET NUMISMATA SCOTIÆ," "a publication," says the sagacious but often too caustic Pinkerton, in his *Enquiry*, "never to be excelled in elegance, and scarcely in exactness." The labour of preparing this great national work had impaired his health and his fortune, notwithstanding the parliamentary aid; and soon after his death, the numerous plates, engraved by Sturt, were sold for L.530; but these plates are now lost, and the book has become exceedingly scarce. After the union of the crowns, Anderson was appointed in 1715 Postmaster-General for Scotland, as some compensation for his valuable labours; but in the political struggles of 1717 he was ungraciously deprived of this office; and never again obtained any reward for his important services to his country. (T. S. T.)

ANDERSON, *John*, professor of natural philosophy in the University of Glasgow, was born in the parish of Roseneath in Dumbartonshire in 1728. He finished his education in that University, where he first became professor of oriental languages in 1756, but in 1760 was appointed to the chair of natural philosophy, a subject more suited to his tastes and acquirements. In this department he laboured assiduously to apply scientific knowledge to the improvement of the mechanical arts. For this purpose he studied their processes in the various workshops of the city, and thus acquired an intimate acquaintance with those operations, which fitted him in an eminent degreee for the great object which seems to have been his chief aim, the scientific instruction of the operative mechanic. He is, in fact, to be considered the father of those Mechanics' Institutions which have since been so widely disseminated in this and other countries. He soon began to open classes for their instruction in the principles of their arts, in which his familiar extempore discourses were illustrated by appropriate experiments. The working mechanic received every encouragement from this eminent man to attend his courses, at which they were received in their working dresses.

His anxiety for the improvement of the humble mechanic was not confined to his personal exertions. Shortly before

 his death in 1796, he bequeathed the whole of his property to 81 trustees, for the purpose of founding an institution for educational purposes in Glasgow. He had seemingly intended it as a sort of rival to the university in which he was himself a professor; for his will mentions the founding of four halls or colleges with nine professors in each, for the faculties of arts, medicine, law, and theology! But the trustees found the funds entrusted to them utterly inadequate to so gigantic a scheme; and they contented themselves with founding what is now called the *Andersonian Institution*, or sometimes less correctly *University*.

It was opened in 1797, by the appointment of Dr Thomas Garnett as professor of natural philosophy, who commenced with a popular course of lectures, which was attended by a considerable audience of both sexes. In 1798 a professor of mathematics and geography was appointed; and the institution has since had the aid of several able teachers. In 1799 Dr Garnett was succeeded by Dr Birkbeck, who had the merit of introducing in the institution a system of scientific instruction annually to 500 operative mechanics, free of all expense to the pupils. On the removal of this excellent man to the London Royal Institution, he was succeeded by Dr Andrew Ure in 1804; and Dr Ure by Dr William Gregory. This institution still flourishes; and has been of vast benefit to the humbler classes of the citizens of Glasgow. (T. S. T.)

ANDERSON, *Robert*, the fourth son of William Anderson, and of Margaret Melrose his wife, was born at Carnwath, in Lanarkshire, on the 7th of January 1750. His father was a *feuar*, that is, a person who possessed some small parcels of real property by the tenure of a perpetual lease. His first destination was for the church: in the year 1767 he was sent to the university of Edinburgh, and in due time was enrolled among the students of divinity. His schoolfellow, James Græme, who had entered the university at the same time, and with the same views, died of consumption in 1772, in the 23d year of his age; and, after a short interval, his faithful friend published a collection of *Poems on several occasions, by James Græme*. Edinb. 1773, 12mo. About this period he relinquished the study of divinity, and betook himself to the study of medicine. He was for a short time employed as surgeon to the dispensary at Bamborough Castle in Northumberland; and in a neighbouring town he then formed connections which had no small influence on his future destiny. On the 25th of September 1777, he married Anne, the daughter of John Gray, Esq. of Alnwick, who was related to the noble family of that name. Returning to Scotland he took the degree of M.D. at St Andrews on the 20th of May 1778, after having been duly examined by the professor of physic. He now began to practise as a physician at Alnwick; but his general habits were rather those of speculation than exertion, and a moderate provision, acquired by his marriage, had emancipated him from the necessity of professional labour. In 1784 he finally returned to Edinburgh, where he continued to reside for the period of 46 years, in a condition of life removed from affluence, but perfectly compatible with genuine independence and comfort. His amiable and affectionate wife died of consumption on the 25th of December 1785, in the 39th year of her age. In 1793, after having remained a widower for eight years, he married Margaret, the daughter of Mr David Dall, master of Yester school in the county of Haddington.

For several years his attention was occupied with his edition of *The Works of the British Poets, with Prefaces Biographical and Critical*, which was published at Edinburgh, and extends to 14 large octavo volumes. The earliest volume, which is now the second in the series, was printed in 1792-3; the 13th was printed in 1795, and another volume was added in 1807. He was frequently solicited to revise his Lives of the Poets, and publish them in a separate form, but after having collected some materials for such a work, he finally abandoned the design. In the mean time he had published *The Miscellaneous Works of Tobias Smollett, M.D., with Memoirs of his Life and Writings*. Edinb. 1796, 6 vols. 8vo. But the most able and elaborate of his productions is the third edition of his *Life of Samuel Johnson, LL.D., with Critical Observations on his Works*. Edinb. 1815, 8vo. The same service which he rendered to Dr Smollett he afterwards extended to Dr Moore, having published *The Works of John Moore, M.D., with Memoirs of his Life and Writings*. Edinb. 1820, 7 vols. 8vo. At an earlier period he had published *The Poetical Works of Robert Blair; containing the Grave, and a Poem to the Memory of Mr Law: to which is prefixed the Life of the Author*. London, 1794, 8vo. And his latest publication was *The Grave and other Poems, by Robert Blair; to which are prefixed some Account of his Life, and Observations on his Writings*. Edinb. 1826, 12mo.

Dr Anderson contributed his ready aid to many different publications, and was always influenced, not by the love of money but by the love of literature. With many eminent men in England, Ireland, and America, he maintained a literary correspondence; and having survived most of his lettered contemporaries, he enjoyed the esteem and consideration of a second and even of a third generation. No part of his character was more conspicuous than his uniform and unabating zeal to promote the success of young men who discovered any promise, however moderate, of literary talent; and some of the more distinguished writers of our own age and nation were not without their obligations to his disinterested friendship. Mr Campbell dedicated to him his earliest and most popular publication, *The Pleasures of Hope*. Thomas Brown, John Leyden, and Alexander Murray, who all died at too early an age, were among the most eminent of his young friends. For Dr Brown, who became professor of moral philosophy in the university of Edinburgh, he entertained a very cordial esteem, which suffered no abatement or interruption. Another prominent feature of his mind was his ardent regard for the civil and religious liberties of mankind. This characteristic he displayed from the first years of manhood till the last day of his earthly existence.

His bodily frame had never been robust; but the uniform temperance and regularity of his habits contributed to prolong a life which was marked by cheerfulness and benevolence. His faculties, mental and corporeal, betrayed few or no symptoms of old age. During the greater part of his last winter he was confined to his own house by what was considered as a common cold, and was attended by his friend and contemporary Dr Hamilton. Of the immediate prospect of death, he spoke, not merely with resignation, but even with cheerfulness; with the subdued but confident hope of one who had long and habitually reposed on the assurances of the Christian faith. He died on Saturday, the 20th of February 1830, after having completed the 80th year of his age; and, according to his own directions, his remains were interred in Carnwath churchyard. His eldest daughter, Anne Margaret, was married in 1810 to David Irving, LL.D., and died in 1812, leaving an only son. His second daughter, Margaret Susannah, lived to deplore the loss of a parent whose declining years she had soothed by the most exemplary attention to all his wants and wishes. (D. I.)

ANDES. The Andes form a mighty mountain chain running nearly parallel to the western coast of South America. The central ridge extends in an undivided chain from the Rio Atrato, at the Isthmus of Darien, in Lat. 8. N., to the Cordilleras of Vilcanoto and Cuzco, in Lat. 15. 50. S., where it separates into western and eastern ridges, that in-

close the extensive and elevated valley of Desaguedero, and exhibit some stupendous peaks that almost rival the altitude of the Himalayas of the East. After running parallel to each other to Lat. 19. 30. S., they again coalesce, and constitute one central chain to the Straits of Magellan, in Lat. 53. The Andes of South America then have a range of about 4200 miles. The most western of the two longitudinal ridges runs parallel to the Pacific, and is called the *Cordillera* of the Coast; the eastern chain is generally termed the *Cordillera* of the Interior, and its northern prolongation *Cordillera Real.* The valley of Desaguedero extends from Lat. 15. 5. to Lat. 19. 30. S., with a varying breadth from 35 to 60 miles, presenting an area of 16,000 square geographical miles. It contains the celebrated Lake of Titicaca, the cradle of Peruvian civilisation. It was on the shores of this lake that Manco Capac, the first Inca, was miraculously discovered by the Quichu, the ancestors of the Peruvians.

The Andes send out, nearly at right angles from their colossal ridge, between the latitudes of 14° and 20° south, three dependent branches, called by the Spaniards also *Cordilleras.* Of these secondary chains, the *first* and most northern is that of the coast of Venezuela, which is likewise the highest and narrowest. With an irregular altitude, it bends eastwards from the Atrato, forming the Sierra of Abibé, the mountains of Cauca, and the high savannahs of Folu, till it reaches the stream of Magdalena, in the province of St Martha. It contracts as it approaches the Caribbean Sea, at Cape Vela; and thence extends to the mountain of Paria, or rather the Galley Point, in the island of Trinidad, where it terminates. This secondary chain attains its greatest known elevation where it rears the snowy summit, or Sierra Nevada, of St Martha and of Merida, the former being nearly 14,000 and the latter above 15,000 feet in altitude. These insulated mountains, covered so near the equator with eternal snow, yet discharging boiling sulphurous water from their sides, are higher than the Peak of Teneriffe, and can be compared only with Mont Blanc. In their descent they leave the Paramo or lofty desert of Rosa and of Mucachi; and on the west side of the Lake Maracaibo they form long and very narrow vales, running from south to north, and covered with forests. At Cape Vela the mountain chain divides into two parallel ridges, which form three confined valleys ranging from east to west, and having all the appearance of being the beds of ancient lakes. These ridges, of which the northern is the continuation of the Sierra Nevada of St Martha, and the southern the extension of the snowy summits of Merida, are united again by two arms which seem to have been placed by the hand of nature as dikes to confine the primeval collections of water. The three valleys thus inclosed are remarkable for their elevation above the sea, rising like steps one above another, the eastmost, or that of the Caraccas, being the highest. This plain was found by Humboldt to be elevated 2660 feet, while the basin of Aragua was only 1350 feet in height, and the Llanos, or reedy plains of Monai, spread within 500 or 600 feet above the level of the shore. The lake of the Caraccas appears to have forced a passage for itself through the *quebrada* or cleft of Tipé, while that of Aragua has been gradually dissipated by a slow process of evaporation, leaving some vestiges of its former existence in pools charged with muriate of lime, and in the low islets called *Aparecidas.* The medium height of the Cordillera of the coast is about 4000 or 5000 feet; but its loftiest summit, next to the Sierra Nevada of Merida, is the *Silla* (or saddle) of the Caraccas, which was visited by Humboldt, and ascertained from barometrical measurement to have an elevation of 8420 feet. Farther to the eastward the mountain chain becomes suddenly depressed, especially its primitive rocks, the beds of gneiss and mica slate meeting as they advance with accumulations of secondary calcareous substances, which envelope them completely, and rise to a great elevation. The incumbent mass of sandstone, with a calcareous base, extending from Capelluari, forms a detached range of mountains in which no trace of primitive rock is found.

The *second* branch, which stretches from the Andes across the American continent, and exhibits a chain of primitive mountains, is named by Humboldt the *Cordillera of the Cataracts of Orinoco.* This very enterprising traveller surveyed it over an extent of upwards of 600 miles, from the Black River to the frontiers of the Great Bara; but the rest of the chain is very little known, running through unexplored wilds and regions almost inaccessible, occupied by fierce and independent tribes of savages. It leaves the great trunk between the 3d and 6th degree of southern latitude, and runs eastward from the *Paramo* or high desert of Tuquillo and St Martin, and the sources of the Guaviari, rearing the lofty summits of Umama and Canavami, and pouring forth the large rivers Meta, Zama, and Ymerida, which form the *roudals* or tremendous rapids of Aturé and Maypuré, the only openings existing at present between the interior of the continent and the plain of the Amazon. Beyond these cataracts the chain of mountains again acquires greater elevation and breadth, occupying the vast tract inclosed between the rivers Caura, Cavony, and Padamo, and stretching southward to the boundless forests where the Portuguese settlers gather that valuable drug the *sarsaparilla.* Farther eastward this chain is not traced, no European or civilised Indian having ever explored the sources of the Orinoco; all access in that quarter being prevented by the ferocity of the Guaicas, a dwarfish but very fair and warlike race, and by the valour of the Guajaribos, a most desperate tribe of cannibals. Beyond these recesses, however, we are made acquainted with the continuation of the chain of the cataracts, by the astonishing journey performed by Don Antonio Santos, who, disguised like a savage, his body naked, and his skin stained of a copper colour, and speaking fluently the several Indian dialects, penetrated from the mouth of the Rio Caroni to the Lake of Parimó and the Amazon. The range of mountains sinks lower, and contracts its breadth to 200 miles, where it assumes the name of Serrania de Quimeropaca and Pacaraimo. A few degrees farther eastward it spreads out again, and bends south to the Canno Pirara along the Mao, near whose banks appears the Cerro or hill of Ucucuamo, consisting entirely of a very shining and yellow mica slate, which has therefore procured from the credulity of early travellers the magnificent appellation of *Dorado* or Golden Mountain. East from the river Essequibo this Cordillera stretches to meet the granitic or gneiss mountains of Dutch and French Guiana, inhabited by confederated bands of negroes and Caribs, but giving birth to the commercial streams of Berbice, Surinam, and Corentin.

The chain of the cataracts of Orinoco has only a mean height of about 4000 feet above the level of the sea. The greatest elevation occurs where the mountain of Duida rears its enormous mass from the midst of a luxuriant plain, clothed with the tropical productions of palms and ananas, and discharges from its steep sides, about the close of the rainy season, volumes of incessant flames. No one has yet had the resolution or perseverance to climb through the tangling and rampant bushes to its peak, which, measured trigonometrically, gives an altitude of 8465 feet above the sea. The whole mountain group which forms this Cordillera is distinguished by the abrupt descent of its south flank; nor is it less remarkable for containing no rock of secondary formation, or exhibiting any vestige of petrifactions and organic remains. It contains only granite, gneiss, mica slate,

and hornblende, without any casing or admixture of sandstone or calcareous matter.

The *third* great branch sent out from the trunk of the Andes is that of the *Chiquitos*, which province it traverses, making a sort of semicircular sweep between the parallels of 15 and 20 degrees south latitude, and appearing to connect the colossal heights of Peru and Chili with the mountains of Brazil and Paraguay. It supplies the rivers that feed the Marañon on the one side, and the Plata on the other. The structure and disposition, however, of the Cordillera of the Chiquitos still remain almost unknown.

These grand chains of mountains divide the southern continent of America, from the latitude of 19 to that of 52 degrees, into three immense plains, which on the west side are shut up by the enormous ridge of the Andes, but are all open on the east, and towards the Atlantic Ocean. The most northern is the valley of the Orinoco, consisting of savannahs or level tracts covered with reedy herbage and scattered palms. The next is the plain of the Marañon, which is entirely covered with dense, impenetrable forests. The third and southernmost valley is the Pampas, a dead flat of most prodigious expanse, clothed, like that of the Orinoco, with a coarse, rank herbage, and abandoned to the occupation of countless herds of wild cattle.

Of these immense plains, the subsoil resembles the composition of the neighbouring mountains. In the valley of the Orinoco, the primitive rock is generally wrapt in a coat of sandstone, with calcareous cement, or covered with calcareous concretions, which betray the vestiges of recent organic remains, but show none of the older impressions, such as the belemnites and ammonites, so common in Europe. The woody plain of Marañon is distinguished by the thinness of its soil, and the total absence of any calcareous ingredients, the granite approaching close to the surface, which is in some places left quite bare over an extent of many furlongs. But the Pampas of Buenos Ayres are covered to a great depth with beds of alluvial deposits, in which the powers of vegetation, fomented by the rays of a burning sun, luxuriate in wanton profusion.

The lake of Titicaca covers a surface of 4000 square miles, being in some places 120 fathoms deep. It has an elevation of 12,795 feet above the sea, and terminates at the mountain Potosi, which rises to 16,000 feet, and is yet covered with the ruins of the ancient Peruvian civilisation. Near this centre the volcano of Arequipa stands, at the height of 18,373 feet, while the double peak of the *Nevados*, or snowy Illimani, tower to the enormous elevations of 24,200 and 24,450 feet, or about 3000 feet above the summit of Chimborazo, which was long regarded as the loftiest pinnacle of our globe. But, in the northern extension of the Cordillera, Sorata rears its snowy head, at the stupendous elevation of 25,200 feet, according to the observation of Pentland.

In those tropical regions cultivation ascends to very near the limits of perpetual snow. Various prolific crops, and particularly wheat and potatoes, are grown at the height of 14,000 feet above the level of the sea. A considerable population, dispersed in towns or villages, occupy tracts about 1000 feet higher, and enjoy health and vigour in a keen atmosphere, twice as rare as at the level of the sea. The ancient Peruvians had worked some gold mines at the vast altitude of 17,000 feet.

Humboldt has shown in his interesting essay, *Sur le Gisement des Roches*, the agreement of the geognostic arrangement of rocks in the Old and New Worlds. Granite appears in both regions the lowest discoverable material of our globe: to it succeeds the laminated species, or gneiss; then mica slate, containing garnets; next primitive slate, with beds of alum slate; now slate mixed with hornblende; above this, greenstone or primitive trap, followed by amygdaloid; and last of the series, porphyry slate. Resting or flanked against those primary rocks, beds of the older limestone begin to appear, with mica slate, hornblende, gypsum, and calcareous sandstone, followed by a suite of minerals bearing indications of organic remains. The only formations which Humboldt did not meet with in his extensive travels, were those of chalk, roestone, graywacke, topaz rock, and the compound of serpentine with granular limestone which occurs in Asia Minor. The grand ridge of the Andes is everywhere covered with porphyry, basalt, phonolite, and greenstone; which being often broken into columns, appear at a distance like ruined castles, and produce a very striking effect. Near the bottom of that enormous chain, two different sorts of limestone occur; one with a silicious base, inclosing sometimes cinnabar and coal; and another mostly calcareous, and cementing the secondary rocks. These formations are of enormous thickness and elevation. "Beds of coal are found in the neighbourhood of Santa Fé, 8650 feet above the level of the sea; and even at the height of 14,700, near Huanco in Peru. The plains of Bogota, although elevated 9000 feet, are covered with gypsum, sandstone, shell-limestone, and even in some parts with rock salt. Fossil shells, which in the Old continent have not been discovered higher than the summits of the Pyrenees, or 11,700 feet above the sea, were observed in Peru, near Micuipampa, at the height of 12,800 feet; and again at that of 14,120, beside Huancavelica, where sandstone also appears. The basalt of Pichincha, near the city of Quito, has an elevation of 15,500 feet, while the top of the Schneekoppe in Silesia—the highest point in Germany where that species of rock occurs, is only 4225 feet above the sea. On the other hand, granite, which in Europe crowns the loftiest mountains, is not found in the American continent above the height of 11,500 feet. It is scarcely known at all in the provinces of Quito and Peru. The frozen summits of Chimborazo, Cayambé, and Antisana, consist entirely of porphyry, which, on the flanks of the Andes, forms a mass of 10,000 or 12,000 feet in depth. The sandstone near Cuença has a thickness of 5000 feet, and the stupendous mass of pure quartz on the west of Caxamarca measures perpendicularly 9600 feet. It is likewise a remarkable fact, that the porphyry of those mountains very frequently contains hornblende, but never quartz, and seldom mica.

"The central Andes are rich beyond conception in all the metals, lead only excepted. One of the most curious ores in the bowels of those mountains is the *pacos*, a compound of clay, oxide of iron, and the muriate of silver with native silver. The mines of Mexico and Peru, so long the objects of envy and admiration, far from being yet exhausted, promise, under a liberal and improved system, to become more productive than ever. But nature has blended with those hidden treasures the active elements of destruction. The whole chain of the Andes is subject to the most terrible earthquakes. From Cotopaxi to the South Sea no fewer than forty volcanoes are constantly burning; some of them, especially the lower ones, ejecting lava, and others discharging the muriate of ammonia, scorified basalt, and porphyry, enormous quantities of water, and especially *moya*, or clay mixed with sulphur and carbonaceous matter. Eternal snow invests their sides, and forms a barrier to the animal and vegetable kingdoms. Near that confine the torpor of vegetation is marked by dreary wastes."—(*Edin. Review*, vol. xv. p. 233.)

We may subjoin that, near Quito, the liquid mud ejected by the volcanoes often involves myriads of small dead fish (*Pimelodes Cyclopum*), and, in some parts, the mountains, like the fabled cave of Æolus, seem at times to let out their imprisoned air, and produce such furious gusts of wind as to

sweep every thing before them to a vast distance. In other districts, the efforts of the contending elements are betrayed, especially during the rainy season, by a doleful moaning noise, or hollow and portentous groans, enough to cast a darker shade on the gloom of superstition, and to fill the imagination of the remotest settler with secret awe and dread.

A person who for the first time climbs the mountains of Switzerland is astonished to witness, in the space perhaps of a few hours, so rapid a change of climate, and such a wide range of vegetable productions. He may begin his ascent from the midst of warm vineyards, and pass through a succession of chesnuts, oaks, and beeches, till he gains the elevation of the hardy pines and stunted birches, or treads on Alpine pastures, extending to the border of perpetual snow. But within the tropics every thing is formed on a grander scale. The boundary of permanent congelation is 7500 feet higher at the equator than at the mean latitude of 45 degrees. Under a burning sun ananas and plantains grow profusely near the shore; oranges and limes occur a little higher; then succeed fields of maize and luxuriant wheat; and the traveller has actually reached the high plain of Mexico, or the still lofter vale of Quito, before he finds a climate analogous to that of Bordeaux or of Geneva. Now only commences the series of plants which inhabit the central parts of Europe.

But the very magnitude of the Andes appears to have the effect of diminishing the impressions of awe and wonder which the sight of them so powerfully excites. The country on which they rest is heaved to such a vast altitude above the sea, that the relative elevation of their summits becomes diminished in comparison with that of the surrounding amphitheatre. The majestic forms of Chimborazo, Cotopaxi, and Antisana, though 6000 feet higher than Mont Blanc, and clothed, like it, with eternal snow, seem to a traveller scarcely more sublime from the plains of Riobomba and Quito, than that celebrated mountain when viewed from the vale of Chamouni. It requires some time for his imagination to expand itself to the new scale of grandeur.

The central Andes, with all their magnificence, want a feature which, in the higher latitudes, contributes so much to the beauty and sublimity of the Alpine scenery. They have no vestige whatever of *glaciers*, those icy belts dropping from the limits of congelation, and spreading in concrete sheets, or hanging in disjointed columns fantastically thrown, which occur alike in the heart of Switzerland and on the northern shores of Norway and Lapland. This defect is evidently owing to the almost uniform temperature which prevails near the equator. In those torrid regions the days are constantly of the same length, and the sun shines through the whole year with very nearly equal force. The limit of perpetual congelation is hence marked on the sides of the mountains of Quito with singular precision. The temperature decreases regularly in proportion as one ascends them, till at a certain altitude it comes to the point of freezing, where the permanent field of snow begins to appear, defined with an almost unvarying border. But in the higher latitudes the sun remains during the summer so long above the horizon, and shines with such augmented force, that the heat of the atmosphere, and consequently of the surface of the ground, suffers a wide alteration in the different seasons. To the general investure of snow is therefore annexed every winter a zone of considerable breadth, which again softens and partly melts away during the continuance of the summer months. This alternate thawing and freezing occasions the production of glaciers, by converting successively the lower detached masses of snow in the precipitous flanks of the mountains, into a collection of broken and intermingled pillars of translucid ice.

For the same reason, the Andes, though torn by flaming volcanoes, and convulsed by frequent and terrible earthquakes, are exempt from those *avalanches* and *éboulements* which in Switzerland and other mountainous parts of Europe often bury the helpless traveller in a torrent of snow, and batter down whole villages by the sudden discharge of a shower of rocks. Under the equator the variation of temperature throughout the year is so small as not to disturb the solidity of the vast collections of snow; but on the flanks of the Alps or Pyrenees, as the heat of the summer increases, portions of the upper field of snow become loosened, and, sliding down, put other masses likewise in motion, till spreading wider, and gaining accelerated force, the whole tide precipitates itself to the plain, sweeping all before it. Such is the accident of an *avalanche;* but the occurrence of an *eboulement*, though less frequent, is more tremendous. When the alternation of frost and thaw detaches a mass of rock, it rolls down the side of the mountain with resistless fury, shivering into fragments and tearing everything opposed to it, overwhelming men, cattle, and houses, in one common heap of ruins.

But the Andes are distinguished from the chains of the European mountains by frightful *quebradas* or perpendicular rents, which form very narrow vales of immense depth, whose terrific walls, fringed below with luxuriant trees and shrubs, seem to lift their naked and barren heads to the distant skies. The noted crevices of Chota and Cutaco are nearly a mile deep, the former measuring 4950, and the latter 4300 feet, in a vertical descent. The task of crossing such tremendous gullies is often a work of infinite toil and extreme danger. In those mountainous countries travellers are accustomed to perform their journeys sitting in chairs fastened to the backs of men called *cargueros* or " carriers." These porters are mulattoes, and sometimes whites, of great bodily strength and activity, who will climb along the face of precipices, bearing loads of twelve and fourteen, or even eighteen stone. The *cargueros* lead a vagabond life, exposed to incredible fatigue, but recommended to them by its irregular course. Often do those wretched men toil over mountains for the space of eight or nine hours every day, till, like beasts of burthen, their backs become chafed and raw with the load. In this deplorable condition they are not unfrequently abandoned by unfeeling travellers, and left alone to sicken, pine, or die in the forests. Yet their earnings would appear inadequate to such violent and overpowering exertions, since they receive scarcely three guineas for performing the journey from Ibague to Cartago, which requires fifteen, and perhaps twenty-five or thirty days.

The Icononzo, remarkable for its natural bridges, is a small *quebrada* or cleft of the mountains, through which flows the river of the Summa Paz, descending from the highest upland desert. The rocks consist of two different kinds of sandstone, the one extremely compact, and the other of a slaty texture, divided into their horizontal strata. The rent was probably caused by an earthquake, which the harder portion of the stony mass had resisted, and now connects the upper part of the chasm. This natural arch is 50 feet long, 40 broad, and 8 feet thick at the middle. Its height is about 300 feet above the surface of the torrent, which has a medium depth of twenty feet. About 60 feet below the natural bridge another smaller arch occurs, composed of three slanting blocks of stone wedged together, which had probably fallen from the roof at the same instant of time, and struck against the sides of the crevice in their descent.

The natural bridge of Icononzo has perhaps no counterpart in the Old World; but the writer of this article had the pleasure of seeing, in early life, a similar phenomenon scarcely inferior to it in the United States of America. We allude to the famous arch described by Mr Jefferson, which crosses the Cedar creek in Rockbridge county, about a

hundred miles beyond the Blue Ridge, in the higher district of Virginia. The divided rock is a pure limestone, leaving a chasm about 90 feet wide, of which the walls are 230 feet high, sprinkled with verdant bushes, and enamelled with gay flowers, among which the *aquilegia* is conspicuous. This bridge, viewed from a little distance below, has all the appearance of a Gothic arch; and is of such solidity, that loaded waggons used formerly to pass along it, till a more convenient line of road was formed.

In some places the natives of Peru connect the clefts of their mountains by pendulous bridges thrown fearlessly across, and suspended from both sides of a gap. They are composed of ropes made of the tough fibres of the *agavé*, hanging in a gently sloping curve, and covered with reeds or canes, with occasionally a narrow border of basket-work. The intrepid Indian, regardless of the horrors of the unfathomed abyss which yawns from below, commits himself to his frail and floating arch, and swiftly glides along its bending curvature, till he gains the opposite bank.

The Andes likewise give rise to waterfalls of immense height and amazing force. The cataract of Tequendama, considered in all its circumstances, rivals any other in the known world. The basin which feeds its streams is the vast plain of Bogota, 7465 feet above the level of the sea, encircled completely with lofty mountains, except where the water, aided probably by the concussion of an earthquake, has cut for itself a narrow passage. The river Funcha, swelled by numerous feeders, gradually contracts its channel to the breadth of about 40 feet, and then gathering augmented force, dashes at two bounds from a perpendicular height of near 600 feet into a dark gulf. Owing to the excessive rapidity and depth of its current, it must discharge a prodigious volume of water, which quite stuns the ear by the roar of its crash; while it raises enormous clouds of thick spray and vapour, that continually bedew, and perhaps quicken, the vegetation of the adjacent grounds. Every thing conspires to exalt the beauty and grandeur of the scenery. "Independent of the height and mass of the column of water," says Humboldt, "the figure of the landscape, and the aspect of the rocks, it is the luxuriant form of the trees and herbaceous plants, their distribution into thickets, the contrast of those craggy precipices, and the freshness of vegetation, which stamp a peculiar character on these great scenes of nature." The transition from a temperate to a warm climate is rapid and surprising. The plain of Bogota bears rich crops of wheat, then succeed oaks and elms, intermingled with aralias, bigonias, and the yellow-bark trees; but immediately below the cataract a few palms appear, as if to mark the advance to a sultry soil.

A lively idea of the character and grand features of the Andes may be conceived from the account which the celebrated Humboldt has given of his journey across that majestic chain. Our readers will be glad to peruse it in the author's own words.

"The mountain of Quindiu, in the latitude of 4° 36′, is considered as the most difficult passage in the Cordilleras of the Andes. It is a thick uninhabited forest, which, in the finest season, cannot be traversed in less than ten or twelve days. Not even a hut is to be seen, nor can any means of subsistence be found. Travellers, at all times of the year, furnish themselves with a month's provision, since it often happens that, by the melting of the snows, and the sudden swell of the torrents, they find themselves so circumstanced that they can descend neither on the side of Cartago nor that of Ibague. The highest point of the road, the Garito del Paramo, is 11,500 feet above the level of the sea. As the foot of the mountain, towards the banks of the Cauca, is only 3150 feet, the climate there is generally mild and temperate. The pathway, which forms the passage of the Cordilleras, is only 12 or 15 inches in breadth, and has the appearance, in several places, of a gallery dug and left open to the sky. In this part of the Andes, as almost in every other, the rock is covered with a thick stratum of clay. The streamlets which flow down the mountains have hollowed out gullies about 20 feet deep. Along these crevices, which are full of mud, the traveller is forced to grope his passage, the darkness of which is increased by the thick vegetation that covers the opening above. The oxen, which are the beasts of burden commonly used in this country, can scarcely force their way through these galleries, some of which are more than a mile in length; and if perchance the traveller meet them in one of these passages, he finds no means of avoiding them but by turning back and climbing the earthen wall which borders the crevice, and keeping himself suspended by laying hold of the roots which penetrate to this depth from the surface of the ground.

"We traversed the mountain of Quindiu in the month of October 1801, on foot, followed by twelve oxen, which carried our collections and instruments, amidst a deluge of rain, to which we were exposed during the last three or four days, in our descent on the western side of the Cordilleras. The road passes through a country full of bogs, and covered with bamboos. Our shoes were so torn by the prickles which shoot out from the roots of these gigantic gramina, that we were forced, like all other travellers who dislike being carried on men's backs, to go barefooted. This circumstance, the continual humidity, the length of the passage, the muscular force required to tread in a thick and muddy clay, the necessity of fording deep torrents of icy water, render this journey extremely fatiguing; but, however painful, it is accompanied by none of those dangers with which the credulity of the people alarms travellers. The road is narrow, but the places where it skirts the precipices are very rare.

"When travellers reach Ibague, and prepare to cross the forests of Quindiu, they pluck, in the neighbouring mountains, several hundred leaves of the vijao, a plant of the family of the bananas, which forms a genus approaching to the Thalia, and which must not be confounded with the *Heliconia Bibai*. These leaves, which are membranous and silky, like those of the *Musa*, are of an oval form, two feet long and 16 inches broad. Their lower surface is a silvery white, and covered with a farinaceous substance, which falls off in scales. This peculiar varnish enables them to resist the rain during a long time. In gathering these leaves, an incision is made in the middle rib, which is the continuation of the foot stalk; and this serves as a hook to suspend them when the movable roof is formed. On taking it down, they are spread out, and carefully rolled up in a cylindrical bundle. It requires about an hundredweight of leaves to cover a hut large enough to hold six or eight persons. When the travellers reach a spot in the midst of the forests where the ground is dry, and where they propose to pass the night, the cargueros lop a few branches from the trees, with which they make a tent. In a few minutes this slight timber-work is divided into squares, by the stalks of some climbing plant, or the threads of the agavé placed in parallel lines 12 or 13 inches from each other. The vijao leaves meanwhile have been unrolled, and are now spread over the above work, so as to cover it like the tiles of a house. These huts, thus hastily built, are cool and and commodious. If, during the night, the traveller feels the rain, he points out the spot where it enters, and a leaf is sufficient to obviate the inconvenience. We passed several days in the valley of Boquia, under one of those leafy tents, which was perfectly dry amidst violent and incessant rains."

For further information relative to the structure of the Andes, see the various sketches given by Humboldt, and

particularly an abstract of his geological observations inserted in the *Journal de Physique*, vol. liii. for 1801. See likewise, by the same author, a memoir on the Geographic and Geognostic labours of M. Pentland, in the *Nouvelles Annales des Voyages et des Sciences Géographiques* for October, November, and December, 1829. (J. L.)

ANDES, the birth-place of Virgil, was a village in the vicinity of Mantua. The modern village of Pietola, about two miles from that city, is supposed to occupy its site.

ANDOCIDES, son of Leogoras, an Athenian orator and soldier, who was implicated with Alcibiades in the charge of mutilating the *Hermæ* of the city, and went into exile for a time. He returned to Athens when Thrasybulus restored liberty to his country. Four orations attributed to him remain; but the authenticity of the one against Alcibiades is disputed.—See Bekker's *Attic Orators*.

ANDORRE, or ANDORRA, *Republic of*, a small state of about 190 square miles in extent, occupying a valley on the Spanish side of the Pyrenees. It is a hilly district, with some good pasture for sheep, and several mines of iron, which are worked by the numerous rapid streams that pass through the district in their course towards Catalonia. It is divided into six parishes, viz., Andorra la Vieja, San-Julian-de-Loria, Encap, Canillo, Ordino, and Masana. Pop. in 1846, from 5000 to 6000. The capital is Andorra, the principal parish of the valley. The Andorrans are a robust and well-proportioned race, of an independent spirit, and simple and severe in their manners. All the inhabitants capable of bearing arms are reviewed once a year. Though each parish has a school, education has made little progress among them. They speak the Catalan language. Their religion is the Roman Catholic. This small state has preserved its independence since the time of Charlemagne, who, about the year 790, declared it a free state in reward for the services the inhabitants had rendered him in assisting his passage through the defiles of the mountains of Catalonia when he was marching against the Moors in Spain. Louis le Debonnaire ceded to the bishop of Urgel a part of the rights over Andorra which Charlemagne had reserved to himself and his successors; and in virtue of this right the bishop still exercises a spiritual jurisdiction over the country. In civil affairs its nominal protector is France, to which it pays an annual tribute of 960 francs for the privilege of importing from that country, free of duty, a stipulated quantity of certain specified articles, the produce of the country being insufficient for the wants of the inhabitants. The Andorrans manfully resisted the invasion of the Spaniards; and, during the wars of the Pyrenees, they rendered to France every assistance in their power. The government is composed of a supreme council of twenty-four members, of whom each parish elects four. The council chooses a syndic, whose office is for life, and who exercises the executive power. Justice is administered by two judges; one nominated by France, the other, who must be an Andorran, by the bishop of Urgel. The former is usually the justice of peace for the canton of Ax. The expenses of government are defrayed by a species of rent paid by owners of flocks to the community for the use of the pasture land.

ANDOVER, a market and borough town in the hundred of the same name, in Hampshire, on the river Anton, and 63 miles from London, on the great road to the west of England. It is well built, and has some trade in shags for silk hats, and in malt. The church is a spacious structure, and existed in the time of William the Conqueror. Andover was a Roman station, and remains of their encampments are still to be seen in the neighbourhood. It returns two members to parliament. A canal connects it with Southampton and the sea. Pop. in 1851, 5395.

ANDOVER, a town in the state of Massachusetts, United States, North America, 21 miles north of Boston, in a pleasant site, on the south banks of the river Merrimac. It has some manufactures; but is chiefly noted for its literary institutions, especially its theological seminary, which was founded in 1807. It has a president and four professors, and a library containing above 20,000 volumes. Tuition and apartments are free to all; and the very indigent receive further aid. There is also Philip's academy for the learned languages, which has a principal master, and three assistants. The number of pupils is limited to 130.

ANDRADA, DIEGO DE PAYVA D', or ANDRADIUS, a learned Portuguese, born at Coimbra in 1528, who distinguished himself at the council of Trent, where he was sent by King Sebastian as one of his divines. He wrote several volumes of sermons, and other pieces; one of which, *De Conciliorum Autoritate*, was highly esteemed at Rome on account of the great extension of authority which it gave to the pope. He died in 1575.

ANDRADA E SYLVA, BONIFACIO JOZÉ DE, a distinguished Brazilian naturalist and statesman, was born in 1765 and died in 1838. He took a prominent part in the Revolution of Brazil, and in 1831 was recalled from his banishment in France to accept the charge of the young emperor's education, but after two years, political hostility again drove him into retirement. His works consist chiefly of memoirs relative to mines.

ANDRÉ, JOHN. This accomplished and unfortunate man was born in London in 1751. Accident led him to Buxton in 1759, where he became acquainted with and deeply enamoured of Miss Honora Sneyd; but her friends disapproving of the match, induced her to discontinue her correspondence with him, and after some years persuaded her to give her hand to Mr Lovell Edgeworth. In the meantime, André, in the hope of improving his circumstances, had engaged in the service of a considerable mercantile house in London; but on the marriage of Miss Sneyd, he determined on abandoning his profession, and soon obtained a commission in a regiment destined for America, the theatre at that time of the war of Independence. In this new sphere, his talents and acquirements gained him rapid promotion, and in the year 1780 he was a major in the army, adjutant-general of the British forces in America, and aid-de-camp to General Sir Henry Clinton, their commander-in-chief.

When in this situation, the American general, Arnold, who had displayed much energy in the cause of the colonics, conceiving himself injuriously treated by his colleagues, made a proposition to the British to betray to them the important post of West-Point, the key of the American position. This seemed a favourable opportunity of concluding the war, and Major André was appointed to negotiate with Arnold. For this purpose he landed from a vessel bearing a flag of truce, and had an interview with Arnold; but before the negotiations were finished, an American fort had fired on the vessel, and forced her to drop down the river. André therefore could not return by the way he came, and it was necessary to go to New York by land: in the meantime, his guide brought him, without his knowledge, within the American lines, where he was provided with a plain dress instead of his British uniform, and a passport under the name of John Anderson, in which disguise he set out on horseback for headquarters. After passing the outposts undiscovered, he was stopped by three militiamen of the enemy and carried back a prisoner. Washington sent him before a court-martial, and notwithstanding a spirited defence, and the remonstrances of the British general, who did all he could to save him, Major André was executed at Tappan as a spy—a sentence perhaps justified by the extreme rigour of martial law, as he had been in disguise within the lines of the enemy; but the traitor Arnold,

through the address of poor André, escaped by timely flight the punishment he justly merited.

Besides courage, and distinguished military talents, Major André possessed a well-cultivated mind. He was a proficient in drawing and in music, and showed considerable poetic talent in his humourous *Cow-chase*, which appeared in three successive parts at New York; the last on the very day of his capture. One of his last letters gives an affecting incident relating to his first love. When stripped of everything by those who seized him, he contrived to retain the portrait of Honora, which he always carried on his person, by concealing it in his mouth. He was not aware that this lady had breathed her last some months before. A mural sculptured monument to the memory of Major André was erected in Westminster Abbey by the British Government, when his remains were brought over in 1821, and there interred. (T. S. T.)

ANDREA Del Sarto, see Vannuchi.

Andrea, *Giovanni*, a celebrated canonist, born (says Tiraboschi) at Bologna, towards the end of the thirteenth century, of parents who were natives of Mugello near Florence. His father kept a grammar school at Bologna; but eight years after the birth of his son, having obtained the living of Sta Maria de' Galluzzi, he took orders, and rebuilt that church at his own expense. Andrea studied civil law under Martino Sulimans and Ricardo Malombra, and canon law under Guido da Baijo. The words *Sub cujus umbra quiesco, et doctor sedeo*, in the beginning of his Decretals, are supposed to have reference, not as commonly asserted to pecuniary assistance from Baijo, but to the professorship which through his interest Andrea obtained at Bologna, whither he removed from Padua where he had previously kept a school. In 1328 he was introduced by Cardinal Bertrando to Pope John XXII. at Avignon. Four years afterwards, when popular fury obliged the cardinal to leave Bologna, Andrea accompanied him to Florence, where he cannot have remained long, for in 1337 he was sent from Bologna on an embassy to Venice and Padua. He was a member of the general council of Bologna in 1340; and if he ever was professor at Pisa, as commonly supposed, it was probably after that period, as no mention of him occurs again until 1348, when it is recorded that he died at Bologna of the plague, and was buried in the church of the Dominicans. The aspersions on the character of this eminent man, must be ascribed to the malevolence of those who envied his great reputation: the titles of *rabbi doctorum, lux, normaque morum*, bestowed on him, prove the public estimation of his learning, and his morals; and R. Volterrano and Filippo Villani testify to his vigils, fasting, and mortification. The story that his accomplished daughter Novella occasionally supplied her father's place in the lecture room, concealed by a curtain lest her beauty should distract the attention of the pupils, appears to rest on very slender foundation; and equally improbable is the common opinion that he named the decretals of Gregory "Novella" in honour of her, that title having probably been given after the example of Justinian in his supplement to the Corpus Juris. Andrea wrote the following works:—*Gloss upon the Sixth Book of the Decretals; Glosses upon the Clementines; Commentary on the Rules of Sextus.* His additions to the *Speculum* of Durando, are taken literally from the *Consilia* of Oldradus; as also the book *De Sponsalibus et Matrimonio* from J. Anguisciola.

Andréa, *Giovanni*, bishop of Aleria in Corsica, a descendant of the family of Bussi or Bossi, was born at Vigevano in 1417. He is celebrated in literary history as having been highly instrumental in introducing printing into Rome, and as the editor of the first editions of several classical authors printed in that city by Sweyheim and Pannartz. The merit of Andréa was the greater, that in early life he had to contend against the disadvantages of extreme poverty. He died in 1475.—Trithemius, *De Script. Eccles.*

Andrea of Pisa. See Pisano.

ANDREÆ, Johann, archivist to the counts of Nassau, about the commencement of the seventeenth century. His voluminous history of that house, which is preserved in MS. in the Walram archives, contains citations from many curious historical documents that were afterwards lost during the thirty years' war.

ANDREANI, Andrea, a celebrated engraver on wood, in chiaroscuro, born at Mantua about 1540. He brought the art to great perfection. His outline is fine, and with a few touches he gives great expression to the heads. His largest work is the *Triumph of Cæsar*, after the cartoons of Andrea Mantegna, now at Hampton Court: perhaps his masterpiece is *Christ retiring from the judgment-seat of Pilate*, in which the Roman Governor is represented as washing his hands. He died at Rome in 1623.

ANDREAS, or Andre, St, a market-town on the Danube, in the circle of Pilesch, and palatinate of Pesth, in Hungary. It contains one Roman Catholic and seven Greek churches, 1040 houses, and 7980 inhabitants, who trade very extensively in the wine produced in the vicinity. In the Danube, opposite to the town, is an island of the same name, which is fourteen miles in length and one in breadth, and remarkable for its fertility.

ANDREASBERG, the capital of the bailiwick of the same name, in the principality of Grubenhagen, kingdom of Hanover. It is 1915 feet above the level of the sea, on the declivity of the Hartz mountains, and contains 4400 inhabitants, who subsist chiefly by mining, the females being employed in making lace. In its vicinity are mines of iron, cobalt, copper, and silver. Lat. 51. 43. N. Long. 10. 31. E.

ANDREINI, Giovanni Battista, born about 1578, was the son of Francesco and Isabella Andreini, both highly celebrated on the Italian stage towards the close of the sixteenth century. Their son is only noticed here as having been the author of a sacred drama, entitled *Adamo*, which was supposed by Voltaire to have suggested to Milton the outline of his *Paradise Lost*, though the original has in reality so little merit that Ginguene sarcastically observes —"*C'est faire trop d'honneur à un tel ouvrage.*"

ANDRELINI, Publio Fausto, born at Forli in Italy. He was a long time professor of poetry and philosophy in the university of Paris. Louis XII. of France made him his poet laureate, and Erasmus tells us that he was likewise poet to the queen. His pen was not wholly employed in making verses, for he wrote also moral and proverbial letters in prose, which were printed several times. Some of his poems, which are chiefly in Latin, are inserted in vol. i. of the *Deliciæ Poetarum Italorum.* He died in 1518.

ANDREOSSY, Antoine-François Comte d', a very distinguished officer of artillery in the service of France, was born in Languedoc in 1761. His family had originally been Italian. He early joined the revolutionary party, was a lieutenant of artillery, and served with distinction in Italy and in Egypt under Buonaparte. In Egypt, he was an active member of the Institute of Cairo, in whose Transactions are several of his memoirs, especially on *The Valley of the Natron Lakes*, and on *The Lake Menzaleh.* He was selected by Buonaparte as one of his companions on his unexpected return to Europe; and served with approbation in his subsequent campaigns. Andreossy was appointed ambassador to London during the short peace of Amiens. When Napoleon assumed the title of Emperor, Andreossy was advanced to be inspector-general of artillery, and to the title of Count of the empire. After various military services, he was appointed ambassador to Austria, where he remained until the rupture with France in 1809; and when the fatal battle

of Wagram prostrated Austria, he became the temporary governor of Vienna. He was long Napoleon's representative at Constantinople, where he acquired the good opinion of Franks and Mahometans. In 1814 he was recalled by Louis XVIII., who sent him, however, the decoration of St Louis. Andreossy then retired into private life, till the escape of his former master from Elba once more drew him forth. After the decisive battle of Waterloo he wholly withdrew from public life, and amused his retirement with preparing for publication different memoirs on scientific subjects, especially his excellent work *Sur le Bosphore de Thrace, comprenant le systeme des eaux qui abreuvent Constantinople*, 8vo, 1818.

His *Histoire du Canal de midi ou de Languedoc* is interesting; but having claimed for his ancestor François Andreossy the principal merit of this undertaking, he was involved in a controversy with the descendants of the engineer Riquet, to whom it has been generally attributed. The decision of the best judges, however, had pronounced in favour of the latter. Andreossy died at Montauban in September 1828. (T. S. T.)

ANDRES, Juan (1740–1817), a native of Valencia. He is the author of a work entitled *Dell' Origine, dei Progressi e dello Stato Attuale d'Ogni Letteratura*, in 7 volumes 4to, the labour of upwards of twenty years, and full of erudition. It has passed through several editions. A just estimate of its merits will be found in Hallam's *Introduction to the Literature of Europe*, vol. i., and in Sismondi's *Literature of the South of Europe* (by Roscoe 1843), vol. i., p. 12, note.

ANDREW, St, the apostle, born at Bethsaida in Galilee, brother to Simon Peter. He had been a disciple of John the Baptist, and followed Jesus upon the testimony given of him by the Baptist. (John i. 35, 40, &c.) He was the first person whom our Saviour received as his disciple. Andrew introduced his brother Simon, and they passed a day with Christ, after which they went to the marriage in Cana (*ibid.* ii.), and at last returned to their ordinary occupation. Some months after, Jesus meeting them while they were both fishing together, called them to him, and promised to make them fishers of men. Immediately they left their nets, followed him (Matt. iv. 19), and never afterwards separated from him. Tradition assigns Scythia, Greece, and Thrace, as the scenes of St Andrew's ministry: he is said to have suffered crucifixion at Patræ in Achaia, on a cross of the form called *Crux decussata* (×), and commonly known as "St Andrew's cross." His relics, it is said, were afterwards removed from Patræ to Constantinople. An apocryphal book, bearing the title of *The Acts of Andrew*, is mentioned by Eusebius, Epiphanius, and others. It is now completely lost, and seems never to have been received except by some heretical sects, as the Encratites, Origenians, &c. This book, as well as a *Gospel of St Andrew*, was declared apocryphal by a decree of Pope Gelasius (Jones *On the Canon*, vol. i. p. 179, *et seq.*)

Andrew, or *Knights of St Andrew*, an order of knights, more usually called the Order of the Thistle.

Knights of St Andrew is also an order instituted by Peter the Czar of Muscovy in 1698, the badge of which is a golden medal, on one side whereof is represented St Andrew's cross, with these words, *Czar Pierre, monarque de toute la Russie.* This medal being fastened to a blue ribbon, is suspended from the right shoulder.

St Andrew's Day, a festival among certain religious denominations, celebrated on the 30th of November in honour of the apostle St Andrew.

ANDREWS, St, a city of Scotland, in the county of Fife, pleasantly situated on a rocky promontory, nearly fifty feet above the level of the sea, in a spacious bay of the German Ocean, into which flow the river Eden, the small rivulet of Kinness, and several other streams. It was formerly a place of much greater extent and importance. At present it is about a mile and a half in circuit, and consists of three leading streets, intersected by a considerable number of smaller streets and lanes. The principal street is well built, is straight and broad, and of late years its appearance, as well as that of the city generally, has been much improved. Several new streets and terraces have been recently formed towards the west, and many elegant and commodious houses erected. The streets are either substantially paved or macadamised, and are furnished throughout with foot-pavement of a superior description; so that, perhaps, no town in Scotland presents a neater or more cleanly appearance. The view of the city, with its many towers and turrets, from the rising ground on the south, or from the level plain on the west, is highly beautiful and picturesque. St Andrews is now much frequented as a summer residence, the principal attractions, in addition to its salubrious air and pleasant walks, being sea-bathing, and the favourite game of golf, of which it may be considered the headquarters in Scotland. The baths have been lately enlarged and greatly improved, and afford every accommodation for cold and warm bathing. St Andrews contains many interesting memorials of antiquity. Of the splendid cathedral, which was founded by Bishop Arnold in 1159, and attained to its highest magnificence in 1318, parts of the east and west ends, and of the south side, are all that now remain. The length of this edifice from east to west was 358 feet within the walls; that of the transept 180 feet. This whole pile of building, which it took 160 years to complete, was in June 1559 demolished in a single day by the iconoclastic fury of the Reformers. About 40 yards to the south-east is the chapel of St Regulus, the tower of which is a lofty square prism, the side of the base being 20 feet, and the height 108. The walls of the chapel to the east of the tower, which was the principal one, still remain; but of a small chapel to the west, which appears to have formerly existed, there is now no trace. The arches of the windows and doors are round, and the figure of some of them is more than half of the circle, which is an undoubted proof of their antiquity. The history of this ancient structure, which was undoubtedly a place of Culdee worship, is involved in great obscurity. The majority of antiquaries assign its erection to a date prior to the ninth century, while some carry it back to the latter part of the fourth century.

The Priory, which was founded by Robert, bishop of St Andrews, during the reign of Alexander I. in 1120, was of great extent, and richly endowed. The prior had precedence of all abbots and priors, and on festival days had a right to wear a mitre and all episcopal ornaments. The wall of the precinct is all that now remains to mark the vast extent of this edifice. This magnificent wall, which surrounded the cathedral and adjacent ecclesiastical edifices, was built by Prior John Hepburn, and was begun about 1516. It is nearly a mile in circuit, about 20 feet in height, and about 4 in breadth.

Part of the top of the great altar towards the east end of the cathedral was discovered half a century ago, in consequence of an excavation made in the hope of finding concealed treasure. At a much more recent period, the soil, which had for ages been permitted to accumulate, having been removed, part of the pavement was laid open, and several shafts of two rows of pillars parallel to each other, by which it is supposed that galleries in the inside of the walls had been supported. The other religious houses were, that of the Dominicans, founded in 1274 by Bishop Wishart; another of Observantines, founded by Bishop Kennedy, and finished by his successor Patrick Graham in 1478; and, according to some, the Carmelites had a fourth. Immediately

St Andrews. above the harbour stood the collegiate church of Kirkheugh, originally founded by Constantine III., who, retiring from the world, became here a Culdee. From its having been first built on a rock, it was styled *Ecclesia Sanctæ Mariæ de Rupe.*

On the north-east side of the city are the remains of the castle, on a rock overlooking the sea. This fortress was founded about the year 1200, by Roger, one of the bishops of St Andrews, and was repaired towards the end of the fourteenth century by Bishop Trail, who died in it in 1401. He was buried near the high altar of the cathedral, with this singular epitaph:

> Hic fuit ecclesiæ directa columna, fenestra
> Lucida, thuribulum redolens, campana sonora.

The castle was the residence of Cardinal Beaton, who, after the cruel execution of the celebrated reformer George Wishart in front of it, was afraid of the fury of the people; and his knowledge of this, joined to his apprehension of an invasion from England, induced him to strengthen the fortifications, with a view of rendering the castle impregnable. In this fortress he was surprised and assassinated by Norman Lesley, aided by fifteen others. Early in the morning of May 29. 1546, they seized on the gate of the castle, which had been left open for the workmen who were finishing the fortifications; and having placed sentinels at the door of the cardinal's apartment, they awakened his numerous domestics one by one, and, turning them out of the castle, without violence, tumult, or injury to any other person, inflicted on Beaton the death he justly merited. The conspirators were immediately besieged in this castle by the regent, Earl of Arran; and although their strength consisted of only 150 men, they resisted his efforts for five months, owing more to the unskilfulness of the attack than the strength of the place; for in 1547 the castle was reduced and demolished, and its picturesque ruins serve as a landmark to mariners. The entrance to the castle, and the window out of which it is said Cardinal Beaton leaned to witness the cruel martyrdom of George Wishart, are still pointed out.

The parish church, situated in South Street, is a spacious structure, 162 feet in length by 63 in breadth, and is large enough to accommodate 2500 persons. It contains a lofty monument of white and black marble, erected in honour of Archbishop Sharpe, who, in revenge for his oppressive conduct, was murdered by some of the exasperated reformers of that day. On this monument is a piece of sculpture representing the tragical scene of the murder. In North Street stands the college church, which belongs to the united college of St Salvator and St Leonard. It was founded in 1458 by Bishop Kennedy, and contains a beautiful tomb of its founder, who died in 1466; which is a fine specimen of the Gothic architecture of that period. About the year 1683, on opening this tomb, six highly ornamented silver maces were discovered, which had been concealed there in times of trouble; three of which are still preserved in the university, and three were sent to the other universities of Scotland. On the top of one of them is represented our Saviour; around are angels with the instruments of his passion.

St Mary's church, also connected with the Establishment, was erected in 1839. It is a plain but neat building, and seated for about 630 persons.

The Episcopal chapel, the Free church, and the United Presbyterian church, are situated in North Street, and are elegant and commodious structures. The Congregationalists and Baptists have also places of worship in the city.

In the United College are shown some silver arrows, with large silver plates affixed to them, on which are inscribed the arms and names of those who were victorious in the annual competitions of archery, which were regularly held until within these few years. Golf is now the reigning game. That sport, and foot-ball, were formerly prohibited by an act of parliament passed in the reign of James II. in 1457, as interfering too much with the acquisition of dexterity in archery, an accomplishment in those days of much consequence to the safety of the state. The statute has been long obsolete, and the inhabitants, and the students who attend the university, have full permission to enjoy this elegant amusement. St Andrews.

The celebrated university of this city was founded in 1411 by Bishop Wardlaw. It consisted formerly of three colleges. 1. St Salvator's was founded in 1458 by Bishop Kennedy. This was a handsome building, with a court or quadrangle, 230 feet long by 150 wide, and a gateway surmounted by a spire 156 feet high. On one side was the church; on another the library; the third contained apartments for students; the fourth was unfinished. 2. St Leonard's College was founded by Prior Hepburn in 1512. This is now united with the last, and the buildings have been sold, and converted into private houses. 3. New or St Mary's College was established by Archbishop Hamilton in 1552. This is said to have been the site of a celebrated school long before the establishment even of the University, where several eminent clergymen taught gratis the sciences and languages; but it was called the *New College*, because of its late erection into a college by the archbishop. The buildings of this college have been substantially repaired, and with great taste.

The United College was constituted in 1747 by the union of St Leonard's and St Salvator's, and occupies the site of the latter. The buildings connected with this college being in a state of great decay, a grant was made by government for erecting a new structure, which is now completed, and is in a high degree elegant and commodious. It is beautifully situated, overlooking the bay of St Andrews and the opposite coast of Angusshire, with the Sidlaw and Grampian hills in the distant north. It is enclosed on three sides by a high wall, and on the south by the College chapel. In front is a spacious area or quadrangle, 215 feet long by 160 feet wide, and behind is a garden neatly laid out in walks and planted with suitable shrubs. A cloister has been erected on the north side of the chapel, as a place of shelter and retirement for the students. Besides ample accommodation for the various classes, the new structure contains a large hall for general meetings of the students, and other academic purposes, and a Museum of Natural History and Antiquities. This museum is connected with the St Andrews Literary and Philosophical Society, which took its rise in 1838, and is principally composed of the professors of the University, and gentlemen resident in the city, who take an interest in the advancement of literature and science. There is also a valuable Anatomical Museum in the College.

The university, which is composed of the members of the United College and St Mary's College, is governed by a chancellor,—an office which it was originally intended should be permanently exercised by the Archbishop of St Andrews. Subsequent to the Revolution, the chancellor has been elected by the two principals and the professors of both colleges.

The rector is the next great officer, to whose care are committed the privileges, discipline, and statutes of the university. The colleges have their principals, and professors of different sciences, who are indefatigable in their attention to the instruction and the morals of the students. The place possesses, in its retired situation, its pure and salubrious air, its extensive grounds for exercise, and its excellent and cheap accommodation for students, very great advantages for the education of youth. In the United Col-

St Andrews.

lege are taught the languages, philosophy, and the sciences. St Mary's, which stands in a different part of the town, is reserved exclusively for theology. The classes and discipline of the two colleges are quite distinct, each having its respective principal and professors. They have a common library, containing nearly 60,000 volumes, and which was formerly entitled to a copy of all new books entered in Stationers' Hall; but, by an act of parliament passed in the year 1837, that right was abolished, and in lieu of it the library receives from the treasury the sum of L.630 annually for the purchase of books. By judicious management it is believed that this arrangement will prove more beneficial to the institution than the privilege it formerly enjoyed.

Eighty-six bursaries or endowments belong to the university, and are conferred on the students. Of these 65 belong to the United, and 21 to the New College. The foundation bursaries in the United College, 20 in number, are disposed of by comparative trial; the remaining bursaries are at the disposal of private patrons.

The Madras College was established in the year 1833, by the late Dr Andrew Bell, a native of St Andrews, and inventor of the monitorial system of education which bears his name, who bequeathed the munificent sum of L.50,000, in three per cent. stock, for its establishment. The building stands on the site of the Blackfriars' monastery. The system of education pursued comprises the classics, the English and other modern languages, writing, arithmetic, mathematics, and drawing. The fees being low, and in many cases not exacted, the institution has been very successful, the number of scholars averaging of late years about a thousand. Dr Bell also left a fund, which yields an annual revenue of upwards of L.300, to be expended on permanent improvements of the city, and educational and religious purposes.

The trade of St Andrews was once very considerable. So late as the reign of Charles I. it had thirty or forty trading vessels, and carried on a considerable herring and white fishery, by means of busses, in deep water, which had for ages been a most profitable branch of commerce, and a source of wealth. During the troubles which followed the death of this monarch, this whole coast, and St Andrews in particular, became a scene of murder and rapine; and every town suffered in proportion to its magnitude and opulence. St Andrews was required to pay a contribution of L.1000, which the inhabitants, after being plundered, were not able to raise: a composition of L.500 was accepted, which was raised by a loan at interest, and has remained a burden upon the corporation, it is believed, ever since.

The harbour of St Andrews is artificial, and is guarded by piers. It has been greatly improved within these few years, and is now pretty safe and commodious; but it is difficult of access, having a narrow entrance, and being exposed to the east winds, which raise a heavy sea on the coast. There is a light on the pier-head, showing green to the west, red to the south-east, and white to the north-east. A turret-light has also been recently erected on the north wall of the cathedral, which, from its elevated position, is of great service to vessels approaching the harbour at night. The shore of the bay is low; and, in the storms of winter, vessels are liable to be driven on it and lost.

St Andrews had a manufactory of sail-cloth to some extent, but it is now discontinued. The game of golf being much practised here, there is a manufactory of golf-balls, which, after supplying the home consumption, used to send about 9000 annually to other parts; but the recent introduction of gutta-percha balls has greatly diminished this source of industry. The shipping of the port consists of a few vessels, which are employed in the coasting trade. St Andrews is a royal burgh, and unites with Cupar, Easter and Wester Anstruther, Pittenweem, Crail, and Kilrenny, in returning a member to parliament. The town-council consists of 29 members, including the provost and four bailies. The number of registered voters in 1853 was upwards of 237, and the amount of poor-rates L.1290.

Andrews.

According to early traditions, St Andrews owes its origin to a Greek monk, Regulus, who, having been warned in a vision to visit Albion, was shipwrecked in the bay about the end of the fourth century. He was hospitably received by the king, who eventually was influenced to establish here the first Christian priests of the country, called *Culdees*. He also directed that the cross of St Andrew should become the badge of the country. In 818, after the conquest of the Picts, he removed the episcopal see to St Andrews, and the bishop was styled *maximus Scotorum episcopus*. In 1474 it was erected into an archbishopric by Sextus IV. at the intercession of James III. In 1606 the priory was suppressed; and in 1617 the power of election was transferred to eight bishops, the principal of St Leonard's College, the archdeacon, the vicars of St Andrews, Leuchars, and Cupar. This see contained the greater part of Fife, with a part of the counties of Perth, Forfar, and Kincardine, and a great number of parishes, churches, and chapels in other dioceses.

The town of St Andrews was erected into a royal burgh by David I. in the year 1140, and its privileges afterwards confirmed. The charter of Malcolm IV., written on a small bit of parchment, is preserved in the tolbooth. Here also are kept the silver keys of the city, which, according to traditionary usage, are to be delivered up to the sovereign on occasion of a royal visit. In this place, likewise, is to be seen the enormous axe with which, in 1646, Sir Robert Spotswood and other distinguished loyalists were beheaded. The town underwent a siege in 1337, at which time it was possessed by the English and other partisans of Baliol; but the loyalists, under the Earls of March and Fife, made themselves masters of it in three weeks, by the help of their battering machines.

St Andrews is nine miles east of Cupar, and 39 N.N.E. of Edinburgh, and is connected with the Edinburgh, Perth, and Dundee railway by a branch line to Leuchars. The population of the parliamentary burgh, according to the census of 1851, was 5084; and of the parish 6716. Long. 2. 50. W. Lat. 56. 19. 33. N. *The History of St Andrews*, by the Rev. C. J. Lyon, contains a detailed account of the city, of its ecclesiastical antiquities, and of the university. (W. P.)

Andrews, *James Pettit*, an English historian and miscellaneous writer, was the younger son of Joseph Andrews, Esq. of Shaw-house, near Newbury, Berks, where he was born in the year 1737. He was educated privately, and is said to have discovered an early taste for literature and the fine arts.

The most extensive work undertaken by Mr Andrews was his *History of Great Britain, connected with the Chronology of Europe; with Notes*, &c. The first volume, which commences with Cæsar's invasion, and ends with the deposition and death of Richard II., was published in 1794, in 4to. A second volume, in which the history is continued from the deposition and death of Richard II. to the accession of Edward VI., appeared in 1795. The plan of this work is new, and in some respects singular; a certain portion of the history of England is given on one page, and a corresponding portion of the contemporaneous history of Europe on the one opposite. The notes consist of a variety of curious and amusing particulars, not immediately connected with the main story. Appendixes are also added at proper intervals, containing an account of the state of literature, science, religion, government, manners, &c., at different periods. The author, however, did not live to complete

this curious and extensive work, no more of it having appeared than the two volumes above mentioned. In 1796 he published a continuation of Henry's *History of Britain*, in one volume 4to and two volumes 8vo, and died at Brompton the following year. He was the author of various other miscellaneous works.

Andrews, *Lancelot*, bishop of Winchester, was born at London in 1555, and educated at Cambridge. After several preferments he was made bishop, first of Chichester, then of Ely, and in 1618 was raised to the see of Winchester. This very learned prelate, who was distinguished by his piety, charity, and integrity, may be justly ranked with the best preachers and scholars of his age. He appeared, however, to much greater advantage in the pulpit than he does now in his works, which abound with Latin quotations and trivial witticisms. He died at Winchester house in Southwark, September 25. 1626, on the anniversary of his birth, and was buried in the parish church of St Saviour's, where his executors erected to him a handsome monument of marble and alabaster, with an elegant inscription in Latin, written by one of his chaplains. His most popular works are his *Sermons*, his *Lectures on the Ten Commandments*, and his *Orphan Lectures*, each forming a folio volume. There is a collection by Felix Kyngston of some other pieces written by him, which was published in 4to in 1629.

ANDRIA, a city and a bishop's see in the territory of Bari, kingdom of Naples, situated in a spacious plain, four miles from the Adriatic. It has a fine cathedral, and a royal college. Pop. 14,600. It derives its name from the caverns in its vicinity. Long. 16. 17. E. Lat. 41. 14. N.

ANDRIANTES, in *Grecian Antiquity*, statues erected in honour of the victors at the public games, a custom which appears to date from the 58th Olympiad. (Paus. vi. 18, § 5.) According to Pliny, it was necessary to have been thrice a victor, to be honoured with a *statua iconica*, or actual likeness. (*Hist. Nat.* xxxiv. 9.)

ANDRIEU, Bertrand, a celebrated engraver of medals, born in 1765 at Bordeaux, where his father was a vintner. He is considered as the restorer of the art in France, which had declined after the time of Louis XIV.; and was so highly esteemed, that during the last twenty years of his life he was entrusted by the French government with the execution of every work of importance. Many of his medals are figured in the *Medallic History of Napoleon.* He died in 1822.

ANDRISCUS, a man of mean extraction, who, pretending to be the son of Perseus, last king of Macedonia, took upon him the name of *Philip*, for which reason he was called *Pseudo-Philippus*, the *False Philip.* After a complete victory over Juventius, the Roman prætor, who was sent against him, he assumed kingly power, but exercised it with great cruelty. At last the Romans obliged him to fly into Thrace, where he was betrayed and delivered into the hands of Metellus, B.C. 148. This victory placed Macedonia once more in the power of the Romans, and gained for Metellus the name of Macedonicus, but cost the Romans 25,000 men. Andriscus adorned the triumph of Metellus, walking in chains before the general's chariot.

ANDROCLUS, a Roman slave who used to lead about the streets a lion which had forborne to injure him when turned loose in the circus. The story is related, on the authority of an eye-witness, by Aulus Gellius (v. 14), who states that Androclus had taken refuge from the severities of his master in a cave in Africa, and that while there, a lion entered the cave and presented to him his swollen paw, from which Androclus extracted a large thorn.

ANDROGEOS, in *Fabulous History*, the son of Minos, king of Crete, was murdered by the Athenian youth and those of Megara, who envied his being always victor at the Attic games. But Minos having taken Athens and Megara, obliged the inhabitants to send him an annual tribute of seven young men and as many virgins, to be devoured by the Minotaur. From this tribute they were delivered by Theseus.

ANDROIDES (ἀνήρ and εἶδος), a human figure, which, by certain springs or other movements, is capable of performing some of the natural motions of a living man. The motions of the human body are more complicated, and consequently more difficult to be imitated, than those of any other creature; whence the construction of an *androides*, in such a manner as to imitate any of these actions with tolerable exactness, is justly supposed to indicate a greater skill in mechanics than any other piece of workmanship whatever.

A very remarkable figure of this kind appeared in Paris in the year 1738. It represented a flute-player, and was capable of performing different pieces of music on the German flute; which, considering the difficulty of blowing that instrument, the different contractions of the lips necessary to produce the distinctions between the high and low notes, and the complicated motions of the fingers, must appear truly wonderful.

This machine was the invention of M. Vaucanson, member of the Royal Academy of Sciences; and a particular description of it was published in the Memoirs of the Academy for that year.

The figure itself was about 5½ feet in height, situated at the end of an artificial rock, and placed upon a square pedestal 4½ feet high and 3½ broad. The air entered the body by three pipes separated one from the other. It was conveyed to them by nine pairs of bellows, three of which were placed above and six below. These were made to expand and contract regularly in succession by means of an axis of steel turned round by some clockwork. On this axis were different protuberances at proper distances, to which were fixed cords thrown over pulleys, and terminating in the upper boards of the bellows, so that, as the axis turned, these boards were alternately raised and let down. A contrivance was also used to prevent the disagreeable hissing fluttering noise usually attending the motion of bellows. This was by making the cord by which the bellows was moved press, in its descent, upon one end of a smaller lever, the other end of which ascending, forced open the small leathern valve that admitted the air, and kept it so till, the cord being relaxed by the descent of the upper board, the lever fell, and the air was forced out. Thus the bellows performed their functions constantly without the least hissing, or other noise by which it could be judged in what manner the air was conveyed to the machine. The upper boards of three of the pairs of bellows, were pressed down by a weight of 4 lb., those of three others by a weight of 2 lb., and those of the three remaining ones by nothing but their own weight.

The three tubes by which the air entered terminated in three small reservoirs in the trunk of the figure. There they united, and, ascending towards the throat, formed the cavity of the mouth, which terminated in two small lips adapted in some measure to perform their proper functions. Within this cavity also was a small movable tongue, which, by its play, at proper periods admitted the air, or intercepted its passage to the flute.

The fingers, lips, and tongue, received their proper directions by means of a steel cylinder turned by clockwork. It was divided into 15 equal parts, which, by means of pegs pressing upon the ends of 15 different levers, caused the other extremities to ascend. Seven of these levers directed the fingers, having wires and chains affixed to their ascending extremities, which being attached to the fingers, caused them to ascend in proportion as the other extremity was

pressed down by the motion of the cylinder, and *vice versa.* Thus the ascent or descent of one end of a lever produced a similar ascent or descent in the corresponding finger, by which one of the holes of the flute was occasionally opened or stopped, as by a living performer. Three of the levers served to regulate the ingress of the air, being contrived so as to open and shut, by means of valves, the three reservoirs of air above mentioned, so that more or less strength might be given, and a higher or lower note produced as occasion required. The lips were, by a similar mechanism, directed by four levers, one of which opened them, to give the air a freer passage; the other contracted them; the third drew them backward; and the fourth pushed them forward. The lips were projected upon that part of the flute which receives the air; and, by the different motions already mentioned, modified the tone in a proper manner. The remaining lever was employed in the direction of the tongue, which it easily moved so as to shut or open the mouth of the flute.

Thus we see how all the motions necessary for a flute-player could be performed by this machine; but a considerable difficulty still remains, namely, how to regulate these motions properly, and make each of them follow in just succession. This, however, was effected by the following simple method: the extremity of the axis of the cylinder was terminated on the right side by an endless screw, consisting of twelve threads, each placed at the distance of a line and a half from the other. Above this screw was fixed a piece of copper, and in it a steel pivot, which, falling in between the threads of the screw, obliged the cylinder to follow the threads, and instead of turning directly round, it was continually pushed to one side. Hence, if a lever were moved by a peg placed on the cylinder in any one revolution, it could not be moved by the same peg in the succeeding revolution, because the peg would be moved a line and a half beyond it by the lateral motion of the cylinder. Thus, by an artificial disposition of those pegs in different parts of the cylinder, the statue was made, by the successive elevation and depression of the proper levers, to exhibit all the different motions of a flute-player, to the admiration of every one who saw it.

The construction of machines capable of imitating even the mechanical actions of the human body shows exquisite skill; but what shall we say of one capable, not only of imitating actions of this kind, but of acting as external circumstances require, as though it were endued with life and reason? This was supposed to have been accomplished by M. de Kempelen of Presburg in Hungary, who constructed an androides capable of playing at chess! Every one who is in the least acquainted with this game must know that it is so far from being mechanically performed, as to require a greater exertion of the judgment and rational faculties than is sufficient to accomplish many matters of greater importance. The inventor came over to Britain in 1785, where he remained above a year with his automaton.

It was a figure as large as life, in a Turkish dress, sitting behind a table, with doors of three feet and a half in length, two in depth, and two and a half in height. The chair on which it sat was fixed to the table, which ran on four wheels. The automaton leant its right arm on the table, and in its left hand held a pipe: with this hand it played after the pipe was removed. A chess-board of 18 inches was fixed before it. This table, or rather cup-board, contained wheels, levers, cylinders, and other pieces of mechanism, all which were publicly displayed. The vestments of the automaton were then lifted over its head, and the body was seen full of similar wheels and levers. There was a little door in its thigh, which was likewise opened; and with this, and the table also open, and the automaton uncovered, the whole was wheeled about the room. The doors were then shut, and the automaton was ready to play; and it always took the first move.

At every motion the wheels were heard; the image moved its head, and looked over every part of the chess-board. When it checked the queen it shook its head twice, and thrice in giving check to the king. It likewise shook its head when a false move was made, replaced the piece, and made its own move; by which means the adversary lost one.

M. de Kempelen remarked that the most surprising circumstance attending his automaton was, that it had been exhibited at Presburg, Vienna, Paris, and London, to thousands, many of whom were mathematicians and chess-players, and yet the secret by which he governed the motion of its arm was never discovered. He prided himself solely in the construction of the mechanical powers, by which the arm could perform ten or twelve moves. It then required to be wound up like a watch, after which it was capable of continuing the same number of motions.

The automaton could not play unless M. de Kempelen or his substitute were near it to direct its moves. A small square box, during the game, was frequently consulted by the exhibitor; and herein consisted the secret, which he said he could in a moment communicate. He who could beat M. de Kempelen was, of course, certain of conquering the automaton. It was made in 1669. His own account of it was, "C'est une bagatelle qui n'est pas sans mérite du côté du méchanisme: mais les effets n'en paroissent si merveilleux que par la hardiesse de l'idée, et par l'heureux choix des moyens employés pour faire illusion."[1] See AUTOMATON.

ANDROLEPSIA, ἀνδροληψία, in *Grecian Antiquity*, a legal procedure allowed by the Athenians against a community harbouring or protecting persons guilty of murder. Certain officers were empowered to seize three men in the city or house concealing the malefactor till he should be surrendered, or satisfaction be made in some way or other for the murder.

ANDROMACHE, the wife of Hector, the mother of Astyanax, and daughter of Eetion king of Thebes in Cilicia. She is one of the noblest female characters in the *Iliad.* After the death of Hector and the destruction of Troy she became the property of Pyrrhus, and afterwards married Helenus the son of Priam, with whom she reigned over part of Epirus.

ANDROMEDA, in *Astronomy*, a northern constellation behind Pegasus, Cassiopeia, and Perseus. It is supposed to represent a female, and has been named in memory of Andromeda, daughter of Cepheus and Cassiopeia, and wife of Perseus, by whom she had been delivered from a sea-monster, to which she had been exposed to be devoured for her mother's pride in boasting that the beauty of Andromeda surpassed that of the Nereids—(Ovid. *Met.* v.) Minerva translated her into the heavens.

Linnæus gave the name of *Andromeda* to a genus of northern Heaths.

[1] When the automaton chess-player was last exhibited in Britain, in the present century, it was obvious to the writer of this note, that a man was concealed in the apparatus. The ostentatious display of all the wheels and levers was never made simultaneously, but one door of the compartments containing them was shut before another was opened; and thus a sufficient space was always allowed for the concealment of a small person; who, after the apparatus was finally closed, could assume a more convenient position in the figure of the Turk, see through its glass eyes, and direct its arms to make the different moves. The writer knows that a diminutive person always accompanied the exhibitor, who was *en secret* always during the performance, was an excellent chess-player, and when the exhibition was over, appeared from his perspiration and exhaustion as if he had been breathing a confined atmosphere.—ED.

ANDRONICUS I. Comnenus, emperor of the East, was the son of Isaac, and grandson of Alexius Comnenus. Naturally active, martial, eloquent, and licentious, both his virtues and vices soon recommended him to the favour of his cousin Manuel, the reigning emperor; and he was appointed to an important command in Cilicia. Afterwards engaging in a treasonable correspondence with the emperor of Germany and the king of Hungary, he was arrested and thrown into prison. After a confinement of about twelve years, and repeated attempts at escape, he at last effected his purpose, and fled for refuge to the court of the great duke of Russia. The cunning of Andronicus soon found means to regain the favour of the emperor; for, having exerted all his influence, he succeeded in persuading the Russian prince to engage to join his troops with those of Manuel, in the invasion of Hungary. After having obtained a free pardon from the emperor, he again fell under his displeasure by refusing to take an oath of allegiance to the prince of Hungary, his intended son-in-law, presumptive heir to the crown, and was dismissed to his former command in Cilicia. Here his insinuating address captivated the heart of Philippa, daughter of the Latin prince of Antioch, and sister to the empress Maria; and in her company he spent his time in all the amusements that country could afford, till the emperor's resentment put a stop to their correspondence. He now collected a band of adventurers, and undertook a pilgrimage to the Holy Land, where he so far succeeded in gaining the favour of the king and clergy, as to be invested with the lordship of Berytus, on the coast of Phœnicia. In this neighbourhood lived Theodora, the beautiful widow of Baldwin, king of Jerusalem. The personal accomplishments and address of Andronicus captivated her heart, and she became the next victim of his artful seduction, and lived publicly as his concubine. Still pursued by the emperor with unabating resentment, he was forced to take refuge in Damascus, and elsewhere, till at length he settled in Asia Minor. While residing there he made frequent incursions into the province of Trebizond, and seldom returned without success. At length Theodora was made captive by the governor of Trebizond, along with her two children, and sent to Constantinople. Andronicus implored and obtained pardon, but was banished to Œnoe, a town on the Euxine coast.

In the year 1180 Manuel died, and was succeeded by his son Alexius II., a youth about twelve or fourteen years of age, without wisdom or experience. The ambition of Andronicus was now again called into action. A civil war, occasioned by the misconduct of the empress in Constantinople, directed the public mind towards Andronicus, as the only person whose rank and accomplishments could restore the public tranquillity. Incited by the patriarchs and patricians, he marched towards Constantinople, which he entered, took possession of the palace, assumed the office of protector, and consigned the empress, her minister, and many persons of distinction, to death. By the voice of his adherents, he was soon after proclaimed emperor and colleague of Alexius. This conjunction of the royal power was soon dissolved by the murder of the unfortunate Alexius. The dead body being brought into the presence of Andronicus, striking it with his foot, he said, "Thy father was a knave, thy mother a harlot, and thyself a fool." Having arrived at the dignity of sole emperor, A.D. 1183, he continued to sway the sceptre with a mixture of justice and bounty towards his subjects at large; but those whom he feared or hated were treated with the most cruel tyranny. The noble families that were either cut off or exiled by him were all allied to the Comneni. Some of these engaged in revolt; and the public calamity was heightened by an invasion of the Sicilians, in which they took and sacked Thessalonica. A rival without merit, and a people without arms, at last overturned his throne. A descendant from the first Alexius in the female line, named Isaac Angelus, being singled out by Andronicus as a victim to his cruelty, fled to the church of Sophia, and there took refuge with several of his friends. Isaac was instantly raised by the populace from a sanctuary to a throne. On the arrival of Andronicus, who was at this time absent from Constantinople, he found himself deserted by all, and was seized and dragged in chains before the new emperor. All his eloquence was of no avail. Isaac delivered him into the hands of those whom he had injured, and for the space of three days he had to endure all the insults and torments that could be inflicted by a populace exasperated by his crimes. At last two Italians, plunging their swords into his body, put a period to his life. His death, in the 73d year of his age, terminated the dynasty of the Comneni, A.D. 1185.

Andronicus II., *Palæologus*, emperor of Constantinople, was assisted in 1303 by a body of adventurers from the west of Europe, against the Ottomans, who were defeated; but the Greek Emperor found his allies not less destructive than his Asiatic enemies. By using bribes, threats, and force, he got rid of his troublesome friends. He was not, however, permitted to live in peace. His grandson Andronicus rebelled in 1320; and after a succession of contests, the elder competitor was forced to abdicate in 1328. During those disgraceful struggles, the common enemy, the Ottomans, completed the conquest of Bithynia, and advanced within sight of Constantinople. The younger Andronicus lived till 1341.

Andronicus of Cyrrha, a Greek astronomer, about B.C. 100, built at Athens an octagon tower, with figures carved on each side, representing the eight principal winds. A brazen Triton at the summit, with a rod in his hand, turned round by the wind, pointed to the quarter from whence it blew. From this model is derived the custom of placing weathercocks on steeples. A considerable portion of this tower still exists, and, instead of "tower of the winds," it should be called *horologium*, the name by which it is designated by Varro.

Andronicus of Rhodes, a peripatetic philosopher, to whom has been attributed the arrangement of the works of Aristotle, after the manuscripts had been brought to Rome by Sulla. Tyrannion the grammarian placed them in his hands, and certain commentaries on the works of Aristotle have been ascribed to him. Andronicus lived about B.C. 60.

ANDROPHAGI, in *Ancient Geography*, the name of a nation whose country, according to Herodotus, was adjacent to Scythia. Their name, compounded of two Greek words, signifies *man-eaters*. See Anthropophagi.

ANDROS, now Andro, one of the ancient Cyclades, lying between Tenos and Eubœa, one mile distant from the former, and ten from the latter. It had formerly a city of great note, bearing the same name, and situated very advantageously on the brow of a hill which commanded the whole coast. In this city, according to Strabo and Pliny, stood a famous temple dedicated to Bacchus. Near this temple Mutianus, as quoted by Pliny, tells us there was a spring called the *gift of Jupiter*, the water of which had the taste of wine in the month of January, during the feast of Bacchus, which lasted seven days. The Andrians were the first of all the islanders who joined the Persians when Xerxes invaded Greece; and therefore Themistocles, after the victory at Salamis, resolved to attack the city of Andros, and oblige the inhabitants to pay large contributions for the maintenance of his fleet. Having landed his men on the island, he sent heralds to the magistrates, acquainting them that the Athenians were coming against them with two powerful divinities, Persuasion and Force, and they must therefore part with their money by fair means or foul. The Andrians replied that they likewise had two mighty

deities, who were very fond of their island, viz., Poverty and Impossibility, and therefore could give no money. Themistocles, not satisfied with this answer, laid siege to the town, but was unable to take it. It afterwards, however, became subject to the Athenians; and, as we are informed by Plutarch, Pericles, a few years after, sent thither a colony of 250 Athenians. It was soon retaken by the Persians; and, on the overthrow of their empire by Alexander the Great, submitted to him, along with the other islands. On his death it sided with Antigonus, who was driven out by Ptolemy. The successors of the last-mentioned prince held it till the time of the Romans, when Attalus, king of Pergamus, besieged Andros at the head of a Roman army, and, having taken it, was by them put in possession of the whole island. Upon the death of Attalus the republic claimed this island, as well as his other dominions, in virtue of his last will.

Andro contains a town of the same name with 5000 inhabitants, and a great many villages. It is the most fruitful island in the Archipelago, and yields a great quantity of silk. The population has been estimated at about 15,000. When visited by Tournefort, Andro contained seven monasteries, a great number of churches, and a cathedral for the bishops of the Roman Catholic persuasion; but most of the inhabitants were of the Greek communion. It now forms part of the kingdom of Greece. It is about 21 miles long and 8 broad. Long. 24. 50. E. Lat. 37. 50. N.

ANDRYCHOW, a city in the circle of Myslenicze, in the Austrian province of Galizia, on the river Wieprzowka, with a castle, and 3000 inhabitants. It has several manufactories of fine damask and other table-linen.

ANDUJAR, a city of Spain, in the province of Jaen, in Andalucia. It is situated near the mouth of the Jandula, on the south side of the Sierra Morena, which defends it from the cold winds of the north. There is an old bridge over the Guadalquiver at this place. The surrounding country is well watered, and yields abundant harvests of wheat, barley, oil, and wine; and numerous hives of bees furnish abundant supplies of honey and wax. From a whitish clay found here, they manufacture a kind of jars called *alcarrasas*, which are highly esteemed for their property of keeping water cool in the hottest summer weather. It contains a castle, five churches, several monasteries, a theatre, and 10,000 inhabitants. Long. 4. 1. W. Lat. 38. 1. 32. N.

ANDUZE, a town of France, in the department of the Gard, seated on the river Gardon. It carries on a considerable trade in serges and woollen cloth, hats, silk, and leather. Long. 3. 42. E. Lat. 43. 39. N. Pop. 4412.

ANECDOTES (ἀνέκδοτα), a term used by some authors for the titles of *Secret Histories;* but it more properly denotes a relation of detached and interesting particulars. The Greek word signifies *things not yet published,* compounded of α privative and ἐκδίδωμι. Procopius gives this title to a book which he published against Justinian and his wife Theodora. Anecdotes is also an appellation given to such works of the ancients as have not yet been published; in which sense Muratori gives the name *Anecdota Græca* to several writings of the Greek fathers, found in the libraries, and first published by him. Martene and Durand have given a *Thesaurus novus Anecdotorum,* in 5 vols. folio.

ANEL, Dominique, an eminent French surgeon, born at Toulouse in 1679. He is celebrated for his successful treatment of aneurism and *fistula lachrymalis;* and was the inventor of the probe and syringe still known by his name. He appears to have died about the year 1722. His works have been published in Amsterdam 1707, and Turin 1713.

ANEMONE (ἀνεμώνη), a genus of plants belonging to the natural order of Ranunculaceæ. The name was given from the supposition that these plants opened to the blowing of the wind (ἄνεμος). See Botany, and Horticulture.

ANEMOMETER, and Anemoscope, machines for measuring the force, and indicating the course, of the wind. See Physical Geography.

ANEMUR, or Anamour, the most southern point of Asia Minor, on the south coast of Caramania. The castle of Anemur stands six miles east of the cape, on the edge of the sea, and extends about 800 feet by 300. Its citadel is placed on a small rocky eminence, and is in a ruinous state. Long. 32. 50. E. Lat. 36. 1. N.

ANEROID BAROMETER. See Barometer.

ANET, a handsome town of France, nine miles north-east of Dreux. It has the ruins of a castle, built for Diana of Poictiers by Henri II., and destroyed in the revolution of 1792. Pop. 1421. Near it is the plain of Ivry, where Henri IV. defeated the armies of the League under Mayenne, in 1590.

ANEURISM, a term in surgery for a dilated artery.

ANGAR, Angan, or Hindsham, a barren and uninhabited island on the Arabian shore of the Persian Gulf, on the south side of the island of Kishma, about 12 miles in circuit. It must have been formerly inhabited, as it contains the ruins of a considerable town, and many reservoirs of water. It has also two wells, and a stream of good water, which unfortunately become dry in the hot weather. It is covered with pits of salt and metallic ores, and a soft rocky substance resembling lava. The hills, which are overspread with shells of oysters and other fish, abound in wild goats, rabbits, and partridges.

ANGARA, Upper and Lower, two rivers of Asiatic Russia, in the government of Irkutsk. The former rises in the mountains of Nertchinsk, and after a westerly course of about 300 miles, falls into Lake Baikal. The latter has its rise in Lake Baikal, near its southern extremity, and passing the town of Irkutsk, falls into the Jenisei after a course of above 1100 miles, forming several waterfalls in its progress.

ANGARI, or Angarii, in *Antiquity,* public couriers appointed for the carrying of messages. The ancient Persians had their ἀγγαρεῖον, which was a set of couriers on horseback, posted at certain stages or distances, always in readiness to receive the royal dispatches from one, and forward them to another, with wonderful celerity, answering to what the moderns call *posts* (*positi*), as being posted at certain places or stages. The angari were also called by the Persians *astandæ.* This system of couriers was adopted by the Roman emperors, and the supplying of the horses and their maintenance was a burden from which the emperor alone could grant exemption.

ANGARIA. See Angari.

ANGAZYA, one of the Comoro Islands, which lie between the north end of Madagascar and the coast of Zanguebar in Africa, from Lat. 11. to 13. S. It is inhabited by Moors, who trade with several parts of the continent, in cattle, fruits, and various commodities of the island, which they exchange for calicoes and other cotton cloths.

ANGEIOTOMY, in *Surgery,* implies the opening of a vein or artery, as in bleeding; and consequently includes both arteriotomy and phlebotomy.

ANGEL, a spiritual being, the first in rank and dignity among created intelligences. The word *angel* in Greek, (ἄγγελος), signifies a *messenger:* the Hebrew מלאך signifies the same thing. The angels are called in Daniel, ch. iv. ver. 13, &c., עירים, or *watchers,* from their vigilance: for the same reason, in the remains we have of the prophecy attributed to Enoch, they are named *Egregori;* which word imports the same in Greek.

The term *Angel* therefore, in the proper signification of

the word, does not import the nature of any being, but only an office; in which sense angels are called the *ministers of God*, and *ministering spirits*. That there are such beings, invisible and imperceptible to our senses, endued with understanding and power superior to those of human nature, created by God, and subject to him,—ministering to his divine providence in the government of the world,—are truths fully attested by Scripture.

The Romans thought the tutelar genii of those who attained the empire to be of an eminent order, on which account they had great honours shown them. Nations and cities also had their several genii. The ancient Persians so firmly believed in the ministry of angels, and their superintendence over human affairs, that they gave their names to their months, and the days of their months, and assigned them distinct offices and provinces: and it is from them the Jews confess to have received the names of the months and angels, which they brought with them when they returned from the Babylonish captivity; after which, we find they also assigned charges to the angels, and in particular the patronage of empires and nations; Michael being the prince of the Jews, as Raphael is supposed to have been that of the Persians.

Although the angels were originally created perfect, yet some of them sinned and kept not their first estate, but left their habitation, and so, from the most blessed and glorious, became the most vile and miserable of all God's creatures. They were expelled the regions of light, and cast down to hell, to be reserved in everlasting chains under darkness until the day of judgment.

ANGEL, a gold coin first used in France, and introduced into England in the reign of Edward IV. It varied in value from that period till the time of Charles I., from 6s. 8d. to 10s. It was impressed with St Michael and the dragon; whence the name.

ANGELICA, a genus of plants of the natural order of the Umbelliferæ. See HORTICULTURE.

ANGELICI, in *Ecclesiastical History*, an ancient sect of heretics, supposed to have received this appellation from their excessive veneration of angels; or from their maintaining that the world was created by angels.

ANGELICS, the name of an order of knights, instituted in 1191, by Angelus Flavius Comnenus, emperor of Constantinople: also, of a congregation of nuns, founded at Milan in 1534, by Lousia Torelli countess of Guastalla, who observe the rule of St Augustine.

ANGELO, MICHAEL. See MICHAEL ANGELO BUONAROTTI.

ANGELO, *St*, the name of several towns and castles in Italy, and particularly the castle of St Angelo at Rome.

ANGELUS SILESIUS, a German philosophical poet, was born in 1624 at Glatz, and died at Breslau in 1677. His real name was *Johann Scheffler*, but he is generally known under the assumed name which marks the country of his birth. Brought up a Protestant, and at first physician to the Duke of Würtemburg, he afterwards embraced the Roman Catholic faith and took orders as a priest.

His peculiar religious faith, founded on his early study of the works of Tauler and Böhme, as expressed in his hymns (*Cherubinisches Wanderbuch*), is a mystical pantheism founded on sentiment. The essence of God he held to be love: God, he said, can love nothing inferior to himself: but he cannot be an object of love to himself without going out, so to speak, of himself, without manifesting his infinity in a finite form; in other words, by becoming man. God and man are therefore essentially one. The following are some specimens of his sayings:—"Nothing exists but thou (God) and I; and when we both exist not, God is no more God, and the heavens fall in." "God was not slain for the first time on the cross, for behold he lies there in Abel already slain." "I am nothing without God, and God were nothing without me." The following lines contain sentiments less startling and paradoxical.

* * * *

The wise man never lacks an aim, an end he can fulfil,
He ever has a guiding star, to wit, God's holy will.

* * * *

The rose needs not a *Why*—it blooms because it can,
Considers not itself, and asks no praise from man.

A selection of his hymns, which are very popular in Germany, was published in 1820, by Varnhagen Von Ense.

ANGER, a painful feeling of the mind, excited by receiving an injury or affront, and accompanied with a disposition to retaliate on the author of the injury. Bishop Butler observes that anger is far from being a selfish passion, since it is produced by injuries offered to others as well as to ourselves, and was designed by the Author of nature not only to excite us to act vigorously in defending ourselves from evil, but to interest us in the defence or rescue of the injured and helpless, and to raise us above the fear of the proud and mighty oppressor.

The same author makes an important distinction, as Dr Reid observes (*Active Powers*, Essay 3), "between sudden anger or resentment, which is a blind impulse arising from our constitution, and that which is deliberate. The first may be raised by hurt of any kind; but the last can only be raised by injury, real or conceived. Both these kinds of anger or resentment are raised whether the hurt or injury be done to ourselves or to those we are interested in."

Physicians and naturalists have recorded instances of extraordinary cases produced by anger. Borrichius cured a woman of an inveterate tertian ague, which had baffled the art of physic, by putting the patient into a furious fit of passion. Valeriola made use of the same means with success in a quartan ague. The same passion has been equally salutary to paralytic, gouty, and even dumb persons; to which last it has sometimes given the use of speech. Etmüller gives instances of very singular cures wrought by anger: among others, he mentions a person laid up by the gout, who being provoked by his physician, flew upon him, and was cured. It has often, on the other hand, been productive of fatal effects. We meet with several instances of princes to whom it has proved mortal, *e.g.* Valentinian the First, Wenceslaus, Matthias Corvinus king of Hungary, and others. There are many instances where it has produced epilepsy, jaundice, cholera, diarrhœa, &c.

ANGERBURG, a circle in the government of Gumbinnen, and province of East Prussia, formerly a part of Poland. It extends over 374 square miles, or 239,360 acres. It is watered by the Angerap, which rises in several lakes, with which the district abounds. Population in 1849, 31,310, engaged in raising corn and flax, and in fresh-water fishing. The females are all employed in spinning linen yarn. Its capital bears the same name, and contained 240 houses and 3451 inhabitants.

ANGERMANNLAND, an old province of Sweden, now forming a part of the province of West Nordland.

ANGERMUNDE, a circle in the government of Potsdam, and province of Brandenburg, in Prussia. It extends over 503 square miles, or 321,920 acres; comprehends six cities, two market-towns, 64 villages; and in 1849 contained 5006 dwellings, and 55,640 inhabitants. The river Oder washes its eastern boundary, and receives the several smaller streams by which it is watered. The borders of the rivers present some excellent meadow-land, on which many cattle are pastured. It produces good corn, tobacco, flax, and abundance of garden fruit. There is much wood land, and several lakes which yield fish in great plenty. The capital,

of the same name, has three churches; and in 1849 contained 373 houses, and 4501 inhabitants, whose chief occupation is making snuff and tobacco.

ANGERONA, or ANGERONIA, in *Mythology*, the name of a mysterious deity whom the Romans prayed to for the cure of the *quinsy*, in Latin *angina*. Pliny calls her the *goddess of silence* and *calmness of mind*, who banishes all uneasiness and melancholy. She is represented with her mouth covered, to denote silent patience. Her statue was erected in the temple of the goddess Volupia, to show that a patient enduring of affliction leads to pleasure.

ANGERS, the ancient *Juliomagus*, a fortified city of France, capital of the arrondissement of the same name, and of the department of Maine and Loire. It is situated on the Mayenne, five miles from its junction with the Loire, and 48 miles E.N.E. of Nantes. It is the seat of a bishop, and of a royal court of justice. Among its buildings may be noticed a fine old cathedral in which Margaret of Anjou was buried, an ancient castle once the residence of the Dukes of Anjou, and the court-house. It has also three parish churches, an academy, a school of arts and trades, a library with 35,000 volumes, a picture gallery, a botanic garden, a museum of natural history, a theatre, &c. The upper and lower town are separated by the River Mayenne. Though lately much improved, it is an ill-built city, and has an air of meanness. It has sailcloth and cotton factories; sugar and wax refineries; tanneries; and a considerable trade in wine, corn, and slates. In its neighbourhood are extensive slate quarries, which give employment to about 3000 workmen. Pop. in 1846, 40,628. Lat. 47. 28. N. Long. 0. 33. W. The arrondissement of the same name is divided into 9 cantons and 88 communes, and by the census of 1846 the population amounted to 152,406.

ANGERSTEIN, JOHN JULIUS, a distinguished patron of the fine arts, was a native of St Petersburg, but of German extraction, and settled in London about the year 1749, where he became one of the most eminent merchants of that period. On Mr Angerstein's death in 1822, his celebrated collection of pictures, consisting of about forty of the most exquisite specimens of the art, was purchased for the use of the public by the English Government, for the sum of L.60,000. This collection was exhibited for some time at the house of the late proprietor in Pall Mall; and became the nucleus of the magnificent collection in the National Gallery, where it was exhibited on the opening of that institution in 1837.

ANGILBERT, ST, secretary and prime minister of Charlemagne, was the most distinguished poet of his age. After filling the highest offices under that monarch with ability and distinction, and receiving the hand of his daughter Bertha in marriage, he retired in 790 to the monastery of Saint Riquier, of which in 794 he was made abbot. He left this retreat from time to time when the king required his services, and in 800 assisted at Rome at his coronation. He died in 814.

Angilbert was called by Charlemagne the *Homer* of his time, but with what justice we cannot say. A poem of his in 68 elegiac verses, addressed to Pepin king of Italy on his victory over the Huns, exists in the collection of Duchesne; another in 30 verses devoted to the praises of St Eloi and St Riquier is to be found with the poems of Alcuin, of whom Angilbert was a pupil and correspondent.

ANGINA PECTORIS, among *Physicians*, is used to signify an anomalous or spasmodic affection of the chest, commonly connected with a diseased state of the heart or large bloodvessels.

ANGITIA, or ANGUITIA (from *Anguis*) an Italian divinity, was believed to have once been a mortal woman, and to have taught the people the use of antidotes for the poison of serpents. After death she received divine honours from the Marsians and Marrubians about the shores of lake Fucinus. She has also been identified with Medea.—Virg. *Æneid*. vii. 759; Serv. *ad Æn*. vii. 750; Sil. Ital. viii. 500.

ANGHIERA, or ANGERA, a beautiful town of Austrian Lombardy, 38 miles north-west of Milan. It stands on a height on the eastern side of the Lago Maggiore.

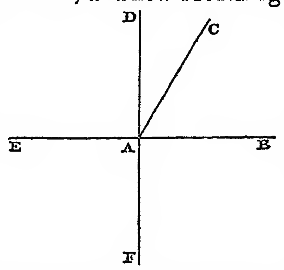
ANGLE. This term is, owing to the poverty of language, employed to signify very different things. In Plane Geometry, it means the opening or separation of two straight lines which meet in a point; but in Solid Geometry, it variously denotes the deviation of a straight line from a plane, the divergence of one plane from another at their line of junction, or even a cluster of plane angles terminating in a common summit. This diversified application of the same word is not likely, however, among mathematicians, to occasion any misconception. But it would be more perspicuous, and certainly more philosophical, to imitate the practice of naturalists in framing a set of cognate words to express the several transitions of meaning.

The word *angle* was drawn from common discourse into the vocabulary of science. Its primitive sense, in all the languages in which it can be traced, is merely a *nook* or *corner*; but it has acquired a more precise and extensive application in its transfer to geometry. In its simplest form, it now denotes generally the *divergence* or difference of direction between two concurring straight lines. Yet a learner still experiences some difficulty in seizing the correct idea of its nature, which has always baffled the attempts of authors to reduce to the terms of a strict definition. Apollonius, at once the most elegant and inventive of the Greek geometers, was satisfied with representing an angle as a *collection of space about a point*,—a description which is not only extremely loose, but which intimates quite a different conception. Euclid, the great compiler of the *Elements*, has defined an angle to be the *κλισις*, or *mutual inclination of two straight lines that meet*. But, in strict language, this definition should apply only to the acute angle, in which one of the sides leans towards the other, and deflects from the perpendicular. Without an extension of the meaning of the term *inclination*, it will not include the obtuse angle, and far less comprehend angles in general; which, since they are capable of repeated additions, must evidently, as much as lines themselves, be susceptible of all degrees of magnitude.

It is indeed impossible, by any combination of words, to express completely and accurately the primary notions which form the ground of geometrical science. The more profitable task is to trace the process by which the mind, refining on external observation, comes to acquire such abstract ideas. We seem to get the idea of *length*, or of *linear extension*, by viewing *progressive* motion; and the enlarged conception of *angles*, or of *angular magnitude*, is easily attained, from the contemplation of *revolving* motion. In opening, for instance, the legs of a pair of compasses, we perceive that their difference in direction gradually increases, keeping pace with the turning at the joint. The quantity of this opening properly constitutes the measure of an angle; and an entire revolution, which brings the moving side of the angle back to its first position, furnishes a *standard* of reference. The bisected revolution marks the divergence of a directly opposite position, or that of two segments of a straight line at their point of separation; and the half of this, again, or the divergence of a line proceeding from the same point, and turned equally aside from both segments, is the *right angle*, which, therefore, being constant, serves to measure all the rest.

Suppose an inflexible straight line AB to turn from right

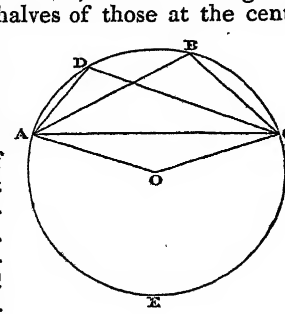
to left, about the point or vertex A. It first comes to the position AC, then to AD, next to AE, and now returning it reaches AF, and lastly it gains its original site AB. The angles thus formed at the point A arise from the combination of successive openings. The angle BAD is composed of BAC and CAD; the angle BAE, or that of direct opposition, is compounded of BAC, CAD, and DAE; and the entire circuit is made of the accumulated angle BAC, CAD, DAE, EAF, and FAB. This circuit, being quartered by the straight lines BE and DF, is divided at the vertex A into four right angles. By comparison, therefore, the angle BAC is acute, and CAE obtuse.



But the side AB can attain the direction AC either by moving onwards, or by turning backwards through the points F, E, and D. The angle compounded of the openings BAF, FAE, EAD, and DAC, may hence be termed appropriately the *reverse* of BAC. The defect of an angle from a right angle is called its *complement*, the defect from two right angles its *supplement*, and the defect from four right angles, or the entire circuit, might be conveniently named its *explement*. Thus, CAD is the *complement* of the angle BAC, CAE is its *supplement*, and the reverse angle BAC its *explement*.

If we consider attentively the formation of angles about a point, we shall be convinced that two concurring straight lines do not contain merely a single angle, but involve an indefinite multitude of angles; in short, that they comprehend all the revolutions and parts of a revolution by which the one line would successively attain the direction of the other. Hence AB will, after describing repeated revolutions, always return into the same position AC. Thus, if A represent the measure of an angle, and C that of a whole circuit, or four right angles; then the primary angle will include likewise $A+C$, $A+2C$, $A+3C$, $A+4C$, continued for ever. Of those successive angles, A, $A+C$, $A+2C$, $A+3C$, $A+4C$, &c. the sines, tangents, and secants are severally the same; and so are the versed sines, the cosines, cotangents, and cosecants. This extension of the doctrine of angles is of the greatest importance in the higher branches of geometry, in the application of trigonometrical formulæ, and in algebraical analysis.

Euclid, in the course of his reasoning, has frequent occasion to combine angles together; and yet he never ventures beyond the consideration of those angles which are less than two right angles. Had he composed his *Elements* after the science of trigonometry came to be cultivated, he could not have failed to take more enlarged views of angular magnitude. In consequence of his narrow conception of the constitution of angles, the Greek geometer is not a little cramped sometimes, and obliged to adopt a circuitous mode of demonstration. For instance, in the 20th prop. of his third book, that "the angles at the circumference are the halves of those at the centre standing on the same arc," he quite overlooks the case of obtuse angles at the circumference. But, in the annexed figure, the angle ABC is clearly the half of the *reverse* angle AOC at the centre, which is subtended by the large arc AEC. It hence follows that the obtuse angles ABC and ADC contained in the same segment must be equal, since they are both of them halves of the same *reverse* angle AOC. Yet, in demonstrating this very obvious corollary, Euclid is constrained to divide the obtuse angles into portions which are shown to be the halves of corresponding angles at the centre. For the same reason he finds it necessary to give a distinct demonstration of the celebrated proposition, that "the angle contained in a semicircle is a right angle." But this property ought likewise to be considered as a mere corollary; for if the radii OA and OC were supposed to extend in one straight line, and thus form the diameter of the circle, their angle AOC would become equal to two right angles, and consequently ABC, its half, would be one right angle. See Leslie's *Geometry*. (J. L.)



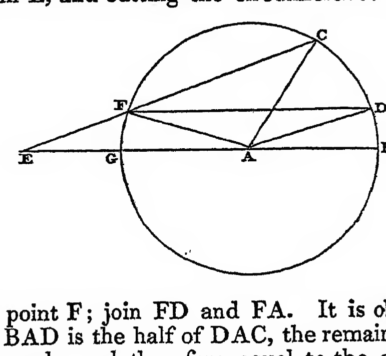
ANGLE *of Incidence*, in *Optics*, the angle which a ray of light makes with a perpendicular to that point of the surface of any medium on which it falls; though it is sometimes understood of the angle which it makes with the surface itself.

ANGLE *of Refraction* now generally means the angle which a ray of light, refracted by any medium, makes with a perpendicular to that point on the surface of which it was incident; but has sometimes been understood of the angle which it makes with the surface of the refracting medium itself.

ANGLE, *Trisection of*. The attempts of the Greek mathematicians to *Double a Cube*, and to *Trisect an Angle*, were their first steps beyond the limits of elementary geometry. They soon perceived that such problems cannot be solved by any combination of mere straight lines or circles. To this conclusion they were led directly by the application of *geometrical analysis*, a beautiful instrument of discovery which Plato had recently invented or improved. Their investigations pointed at some curves of a higher order than the circle, and opened to them a wide and interesting field of research.

The analysis of the trisection of an angle, conducted in two different ways, terminates in the construction of the *conchoid*, a complex curve which was first proposed by Nicomedes. As the subject is very curious, and throws great light on the theory of angular magnitude, we shall here not only give both the ancient methods of investigation, but subjoin a third which is due to the sagacity of Newton.

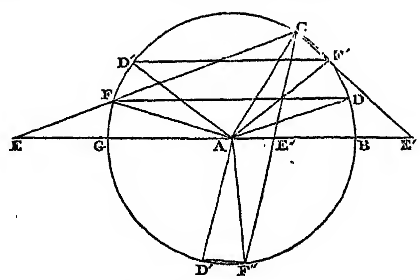
1. Let it be required to trisect the angle BAC or the arc BC. Suppose the thing already done, and the angle BAD to be the third part of the given angle. From the point C draw CE parallel to AD, meeting the extended diameter in E, and cutting the circumference of the circle in the point F; join FD and FA. It is obvious that the angle BAD is the half of DAC, the remaining part of the whole angle, and therefore equal to the angle DFC at the circumference. But AD and EC being parallel, the angle BAD is equal to AEF, which is hence equal to DFC; and consequently FD is parallel to EB. Wherefore the arc BD is equal to GF, and the angle BAD equal to GAF. The angle AEF is thus equal to EAF, and hence the side EF is equal to AF, the radius of the circle.



To solve the problem, therefore, it would be requisite to inflect from C a straight line CFE, such, that the portion FE, intercepted between the circumference and the diameter, or its extension, should be equal to the radius of the circle. The radius AD, drawn parallel to this inflected line CE, would cut off an angle BAD, which is the third part of the given angle BAC.

But elementary geometry will not in general furnish the means of inflecting CE, according to the required conditions. This must be done either tentatively, that is, by repeated trials, or by the application of a curve, so constituted that every straight line drawn from the *pole* C to the *directrix* BG shall have the portion EF, intercepted by the curve, equal to AB. This curve is, from its general shape or resemblance to a *conch* or shell, named the *conchoid:* it consists of two branches, one above the directrix called the *interior conchoid*, and the other below it called the *exterior conchoid*. The conchoid being described, will, by its intersection with the circumference of the circle, give the point F, and consequently the position of the trisecting line AD′. But such a complex curve must cut the circumference in more points than one, and consequently the problem of angular trisection, viewed in its generality, admits of several answers. In fact, there are always *three* distinct positions of the inflected line CE, which will fulfil the conditions of the problem.

It is curious to examine these different positions of the inflected line. Draw AD′ parallel to the *second* position CE′, and join D′F′, AD′, and AF′. Because AF′ is equal to E′F′, the angle E′AF′ is equal to AE′F′; and, consequently, the exterior angle AF′C is the double of either of these. But CAF′ being an isosceles triangle, AF′C is equal to ACF′, which again is equal to the alternate angle CAD′; wherefore CAD′ is the double of the angle AE′F′; and being likewise the double of CF′D′ at the circumference, the angles CF′D′ and AE′F′ are equal, and, consequently, F′D′ and E′A parallel. Now the angle CAD′ being double of E′AF′ or D′AG, and the angle CAD double of DAB, the arc DCD′ is double of the arcs D′G and DB, which serve to complete the semicir-

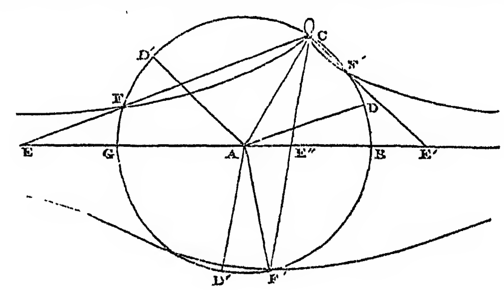


cumference; wherefore this arc DCD′ is two third parts of the semicircumference, or one third of the whole circumference.

In the *third* position AD″ of the trisecting line, draw CF″ parallel to it, and join AF″ and D″F″. The isosceles triangles D″AF″ and AF″E″ have equal vertical angles; and, consequently, the angles at their base are likewise equal; wherefore AF″D″ is equal to the alternate angle F″AE″, and the chord D″F″ parallel to the diameter BG. But the reverse angle CAD″ standing on the arc CD′D″ is double of the angle CF″D″ at the circumference, and therefore double of BE″F″ or of BAD″; and the angle CAD being by the first construction likewise double of BAD, the reverse angle CAD″, together with CAD, must be double of BAD″ and BAD, or the arc CD′GD″ is double of DBD″, which completes the circumference. Hence the arc DD′D″ is two thirds of the circumference.

It thus appears that the construction of the problem assumes three different aspects, and that the trisecting lines, to which a close analogy conducts us, mutually divide the whole circuit into equal portions. These results are perfectly conformable with the theory of angular magnitude. For if A denote the arc BC, and C the whole circumference, this arc will be generally expressed by A, A+C, A+2C, &c.; consequently, the third part will be expressed by $\frac{1}{3}$A, $\frac{1}{3}$A$+\frac{1}{3}$C, $\frac{1}{3}$A$+\frac{2}{3}$C, &c., which evidently correspond to BD, BD′ and BD″. But any farther extension of this progression only brings the trisecting line back into its former positions.

To solve completely, therefore, the problem of the trisection of an angle; from the pole C, on either side of the directrix BG, with a measure equal to the radius of the circle, describe the exterior and the interior or nodated conchoid; draw CF, CF′, and CF″ to the three points of intersection with the circumference, and the radii AD,

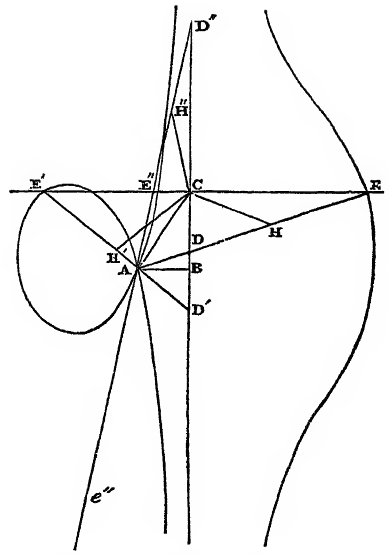


AD′, and AD″ parallel to these will mark the triple section of the angle BAC.

It may be perceived that the exterior branch of the conchoid cuts the under semicircle in another point besides F. This occurs in the extension of the radius CA, or where the diameter passing through C, the extremity of the original arc, meets the opposite circumference; the portion of the inflected line, intercepted below BG by the conchoid, being evidently equal to the radius. The fourth intersection, however, affords no real solution, but only exhibits the amount of repeated division, as completing the arc itself.

2. But another analysis leads to a similar result. Let the angle BAD, as before, be the third part of BAC; draw BC perpendicular to AB, and CE parallel to it, meeting AD produced in E. The right angle DCE would be contained in a semicircle having DE for its diameter; join C with the centre H, and the triangle CHE being isosceles, the exterior angle CHA is double of CEH, or of the alternate angle BAD, and therefore equal to the remaining portion CAD of the divided angle BAC. Whence the triangle ACH is isosceles, and the side CA equal to HC, or the diameter DE must be double of AC.

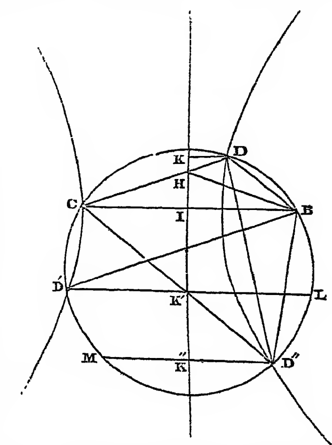
The construction of the problem is thus reduced to the drawing from the vertex of the given angle a straight line ADE, such, that the part DE, intercepted between the perpendiculars BC and CE, shall be equal to the double of AC. This can only be done by describing a conchoid from the pole A to the directrix BC, and with the double of AC as the measure; the intersection of the curve with the perpendicular CE will determine the position of the trisecting line ADE. The exterior branch of the conchoid will cut the perpendicular in the point E, and the interior or nodated branch will meet and cross it at the two points E′ and E″. The radiating lines AE, AE′, and AE″, or its extension Ae″, will indicate the complete trisection of the angle BAC. These lines will be found, as in the first construction, to make angles with each other that are equal to the thirds of an entire circuit. It may be worth while to examine the several cases.



In the *second* position D′AE′ of the trisecting line, draw CH′ to the middle point. Because the triangle E′H′C is isosceles, its exterior angle CH′A is double of CE′H′, or of the angle BAD′; but H′CA being also an isosceles triangle, CH′A is equal to CAH′, and consequently double of BAD. Add CAD, which is double of BAD, and the compound angle DAE′ is double of DAD′, which would complete two right angles; whence DAE′ is two thirds of two right angles, or one third of a whole circuit.

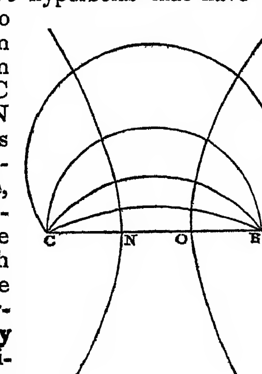
In the *third* position, AE″D″ of the trisecting line, or rather its extension Ae″, draw CH″ to bisect E″D″. The triangles CH″D″ and ACH″ are then isosceles, and consequently the angle CAD″ or CH″A is double of CD″A; but CAE is likewise double of CEA, and therefore the combined angle D″AE is double of the angles CD″A and CEA. Now this angle D″AE, together with the two angles CD″A and CEA, is evidently equal to the exterior angle DC″E or a right angle. Whence D″AE is two thirds of a right angle, or one third of two right angles, and therefore the adjacent angle DAe″ is two thirds of two right angles, or one third of a whole circuit.

3. The simplest and most elegant solution of the trisection of an arc was indicated by Pappus, and is given in Castillon's Commentary on Newton's *Universal Arithmetic.* The problem is there reduced to the combination of the circle with a certain kind of hyperbola. But the general property of the directrix, which belongs to all the conic sections, or the lines of the second order, affords the readiest mode of investigation. Let the arc BD be the third part of BDC. Complete the circle, and draw the chords BD, BC, and CD. The arc CD is evidently double of BD, and therefore the angle CBD is double of BCD. Bisect the angle CBD by the straight line BH, let fall the extended perpendicular, and draw the parallel DK. The triangle CHB is evidently isosceles, and HI bisects the base CB. But the triangle CBD having its vertical angle at B bisected, the side CB is to BD as the segment CH of the base to HD; that is, since the triangles CHI and DHK are similar, as CI to KD; wherefore, CB being the double of CI, BD is likewise double of DK. The ratio of the distances BD and DK is thus given, while the point B is given, and the straight line IH given in position. Whence, from the theory of lines of the Second Order, the locus of the point of section D is an *hyperbola*, of which B is a focus, and IH a directrix, with the determining ratio of two to one. Let this construction be made, and the arc CDB is trisected in D. For since BD is, from the property of the curve, double of DK, it is evident that BC is to CI as BD to DK; and the triangles CIH and KDH being similar, and CI to CH as DK to DH, it follows that BC is to CH as BD to DH, or alternately BC is to BD as CH to DH. Wherefore the vertical angle CBD is bisected by BH, or the angle CBD is double of CBH or of BCD, and consequently the arc CD is double of BD, or BD itself is the third part of the whole arc CDB.



But the opposite branch of the hyperbola, which passes through C, also comes into play; and the intersection of these two branches with the circle assigns three different positions of the point D, separated from each other by intervals equal to the third of the whole circumference. Thus, in the *second* position D′, produce the perpendicular D′K′ to the opposite circumference L; and since BD′ is double of D′K, it must be equal to the chord D′L, and consequently the arc BDCD′ is equal to LD″MD′. Wherefore the double of BDCD′, together with the interval BL or CD′, is equal to the whole circumference; that is, the double of DCD′, with the double of BD and CD′, is equal to the whole circumference; and since the double of BD is DC, the triple of the arc DCD′ must complete the circumference. In the *third* position D″, produce the perpendicular D″K″ as before: the double of this, or the chord MD″, is hence equal to D″B, and the arc BLD″ equal to DM: consequently the double of BLD″, with the compound arc BDCM, completes the circumference; but D″M being parallel to BC, the arc BLD″ is equal to CD′M, and therefore three times the arc BLD″, with the arc BDC, or the triple of BD, will fill up the circumference, or the arc DBD″ is a third part of it.[1]

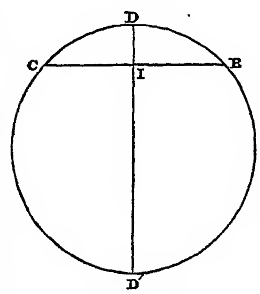
The trisection of innumerable arcs described on the same chord is rendered very conspicuous by combining the separate branches of two hyperbolas that have the determining ratio of two to one, and their foci situate in the extremities of the given line. Thus, let the chord BC be trisected at the points N and O, and from B and C, as distinct foci, and in the determining ratio of two to one, describe branches of independent hyperbolas. All the arcs erected on BC are each of them divided by those curves into three equal portions. These arcs, as they flatten, approach to the trisected chord CNOB on the



[1] For more illustration of this subject, see Leslie's *Geometry of Curve Lines.*

one hand; and as they become enlarged, they constantly tend, on the other, to the complete circumference which the asymptotes of the hyperbola, making angles on each side of the axis equal to two thirds of a right angle, would themselves trisect.

It may be observed in general, that the section of an arc or angle admits of as many different answers as the number of divisions proposed. Thus, the quadrisection would give four distinct results, and a quinsection would involve no fewer than five separate products. Nay, the bisection itself of an arc, though within the limits of the most elementary geometry, yet brings out a double result. Thus, the arc CDB is bisected by the perpendicular or diameter DID′, which not only gives BD for the half of that arc, but also BDCD′, or the same half-arc augmented by a semicircumference.



These conclusions agree with the results derived from the general theory of equations. The expression for the sine of a multiple arc is always an equation of corresponding dimensions, which therefore admits of as many distinct roots as the index contains units.

The ancient geometers were only acquainted with the original division of the circumference into two, three, or five equal portions. The only subdivisions were obtained from the differences of those arcs or their continued bisection. But the very ingenious Professor Gauss has discovered a series of more complex regular polygons, which may be inscribed in a circle by elementary geometry. The expression $2^n + 1$, when a prime number, will represent the sides of the figure: for the general equation of a cosine of the section can be decomposed into quadratics of the simplest kind, which can be constructed by the repeated application of circles and straight lines. A polygon of 17 sides is the first that occurs after the pentagon; and then follow the polygons of 257, 65537, &c. (J. L.)

ANGLES, an ancient German nation, originally a branch of the Suevi; who, after various migrations, settled in that part of Denmark now called Schleswig. (A district in Holstein still bears the name of Angeln.) Here they were known, even in the time of Tacitus, by the name of *Angli*. The origin of this name is variously accounted for. According to Saxo Grammaticus, they were called *Angli*, from one Angulus, son of Humblus king of Denmark. Goropius derives their name from the Saxon word *Angel* or *Engel*, signifying a fish-hook; the Angles, like the other Saxon nations, being greatly addicted to piracy, and on that account being so named by the neighbouring nations; as if, like hooks, they caught all that was in the sea. To this nation the British ambassadors are said to have applied when soliciting succours against the Scots and Picts. The Angles, therefore came over in greater numbers than any other Saxon nation, and accordingly had the honour of giving the name of *Anglia* to England.

ANGLESEA, or ANGLESEY, an island of North Wales, forming the county of that name. It is divided from the main island of Great Britain by the narrow armlet of the sea called the Straits of Menai. Over this water a magnificent suspension bridge was completed in January 1826. Still more recently, in 1850, a railway has been carried across the strait through a stupendous tubular bridge, constructed of iron. See MENAI STRAIT, and TUBULAR BRIDGES. The extent of the county is about 271 square miles, or 173,440 acres. The soil is but moderately fertile; but in average years it yields more barley and oats than the consumption requires. The surplus generally finds a market in Liverpool. A number of horned cattle, sheep, and hogs, are annually sent over the Menai. The most valuable product of the island arises from the mines. The chief of these, the Parys mine, was once the most abundant in copper ore of any mine in the world; and even in the water lodged beneath the bed of ore, quantities of nearly pure copper are obtained by exposing it to iron. A mine of lead, but rich in silver, has been discovered near the same mountain. Quarries of various kinds of marble, and mines of asbestos, also are found on the island. Coal is obtained at Maltreath in considerable quantities. The mines have, however, of late greatly diminished in productiveness, especially those of copper. The herring fishery in some years gives employment to a portion of the inhabitants.

The island has been celebrated in the most remote periods as the seat of the druidical pontiff, and the great nursery of the instructors in that kind of religion or superstition, of which but little has been handed down by any other mode than by tradition, and which is attended with the doubts and uncertainty naturally arising from that mode of communication. See the article DRUID.

At present the Welsh language, of the northern dialect, is almost the exclusive language of the peasantry; but in the towns, especially at Holyhead, English is very generally understood. The county is divided into 6 hundreds and 76 parishes. The number of inhabitants in 1841 was 50,891; and in 1851, 57,327. The county returns one member to parliament, and one is also returned by the boroughs of Beaumaris, Holyhead, Amlwch, and Llangefni.

ANGLING.

ANGLING, or the art of fishing with rod and line, includes those branches of the piscatorial trade which are usually followed, not so much for profit, as for pleasant recreation. That the practice of "casting angles into the brook" had its origin in necessity, the mother of so many inventions, can hardly be doubted; but it is equally clear that the refined skill exhibited in this pursuit at the present day has been derived from leisure and the love of sport, aided by the more delicate gear which modern ingenuity has invented for the deception of the finny race.

The comparative merits of angling, and of the kindred occupations of the fowler and the huntsman, are not likely to be determined by any portraiture which a lover of these exciting amusements might draw of their various excellencies, but must depend on the tone and temper of mind possessed by different persons, and their greater or less accordance with individual tastes. This much, however, may be safely stated as a general and admitted truth, that the value of a pursuit increases in proportion as it becomes attainable by the mass of our fellow-creatures; and as angling is a much cheaper and more convenient pleasure than either hunting or shooting, it may, in so far as regards those advantages, claim a decided preference. Be it remembered that Dr Johnson's description of a rod with a fly at one end and a fool at the other

 is not admitted among the memorabilia of the lovers of old Izaak Walton.

The recreation of angling has been followed by many of the best and wisest of men in modern ages. Sir Henry Wotton found from experience, that after prolonged study or worldly occupation, it was "a rest to his mind, a cheerer of his spirits, a diverter of sadness, a calmer of unquiet thoughts, a moderator of passions, a procurer of contentedness;" and, besides the immediate excitement of the sport itself, few occupations yield so much pleasure to the lovers of rural scenery and the admirers of the picturesque. The most beautiful scenes in nature usually adorn or consist of the banks of lakes and rivers; and the composition of a perfect landscape, whether in nature or art, is incomplete without the accessory of either tranquil or flowing waters. The pursuits of the artist and the angler are therefore peculiarly compatible, and each lends an interest to the other.

The lofty woods, the forests wide and long,
Adorn'd with leaves and branches fresh and green,
In whose cool bowers the birds with many a song
Do welcome with their quire the summer's queen;
The meadows fair, where Flora's gifts among
Are intermixed with verdant grass between;
The silver scaled fish that softly swim
Within the sweet brook's crystal watery stream:

All these, and many more of HIS creation,
That made the heavens, the angler oft doth see;
Taking therein no little delectation,
To think how strange, how wonderful they be;
Framing thereof an inward contemplation,
To set his heart from other fancies free;
And whilst he looks on these with joyful eye,
His mind is rapt above the starry sky.

Markham, in his *Country Contentments*, describes not only the outward apparel, but the inward qualities, of an angler. He must be generally accomplished in all the liberal sciences, and, as a grammarian, ought to be qualified to write and discourse of his art in true and fitting terms. He must be possessed of *sweetness of speech* to entice others to so laudable an exercise, and of strength of argument to defend it against envy and slander. "Then must he be strong and valiant, neither to be amazed with storms, nor affrighted with thunder; and if he is not temperate, but has a gnawing stomach that will not endure much fasting, but must observe hours, it troubleth the mind and body, and loseth that delight which only maketh pastime pleasing." "He must be of a well-settled and constant belief, to enjoy the benefit of his expectation; for then to despair, it were better never to be put in practice: and he must ever think when the waters are pleasant, and any thing likely, that there the Creator of all good things hath stored up much of plenty; and though your satisfaction be not as ready as your wishes, yet you must hope still, that with perseverance you shall reap the fulness of your harvest with contentment. Then he must be full of love both to his pleasure and his neighbour—to his pleasure, which otherwise will be irksome and tedious—and to his neighbour, that he never give offence in any particular, nor be guilty of any general destruction: then he must be exceeding patient, and neither vex nor excruciate himself with losses or mischances, as in losing the prey when it is almost in the hand, or by breaking his tools by ignorance or negligence; but with pleased sufferance amend errors, and think mischances instructions to better carefulness."

In regard to the antiquity of angling, it has been traced by some to the time of Seth, who is asserted to have taught it to his sons; and so highly have others esteemed the knowledge of the art, as to maintain that its rules and maxims were engraven on those pillars by which an acquaintance with music, the mathematics, and other branches of useful knowledge, was preserved by God's appointment from extinction in the days of Noah. It is frequently alluded to in the holy Scriptures; as in Isaiah, xix. 8, "The fishers also shall mourn, and all they that cast angle into the brooks shall lament, and they that spread nets upon the waters shall languish;" so in the prophet Habbakuk, i. 15, "They take up all of them with the angle, they catch them in their net, and gather them in their drag; therefore they rejoice and are glad." We deem it unnecessary to multiply quotations from ancient authors, whether sacred or profane; but shall rest satisfied with pointing out, at the close of this article, the principal works on angling which have appeared in our own language, and in relation to the practice of the art in British streams.

As expert angling never was and never will be successfully taught by rule, but is almost entirely the result of assiduous and long-continued practice, we purpose being very brief in our disquisition on the subject. We shall commence by stating our belief that fly-fishing, by far the most elegant and interesting branch of the art, ought not to be regarded exclusively as an art of imitation. It no doubt depends on deception, which usually proceeds on the principle of one thing being successfully substituted in the likeness of another; but Bacon's distinctive definitions of simulation and dissimulation place the subject in a truer light. As simulation consists in the adoption or affectation of what is not, while dissimulation consists in the careful concealment of what really is—the one being a positive, the other rather a negative act—so the great object of the fly-fisher is to dissimulate in such a manner as to prevent his expected prey from detecting the artificial nature of his lure, without troubling himself by a vain effort to simulate or assume, with his fly, the appearance of any individual or specific form of insect life. There is, in truth, little or no connection between the art of angling and the science of entomology; and therefore the success of the angler, in by far the greater proportion of cases, does not depend on the resemblance which subsists between his artificial fly and the natural insect. This statement is no doubt greatly at variance, as well with the principles as the practice of all who have deemed fishing worthy of consideration, from the days of Isaiah and Theocritus, to those of Carrol and Bainbridge. But we are not the less decidedly of opinion, that in nine instances out of ten a fish seizes upon an artificial fly as upon an insect or moving creature *sui generis*, and not on account of its exact and successful resemblance to any accustomed and familiar object.

It may be asked, upon what principle of imitative art the different varieties of salmon-fly can be supposed to bear the most distant resemblance to any species of dragonfly, to imitate which we are frequently told that they are intended? Certainly no perceptible similarity in form or aspect exists between them, all the species of dragonfly, with the exception of one or two of the sub-genus Calepterix, being characterized by very clear, lace-like, pellucid wings, entirely unadorned by those fantastic and gaudy colours, borrowed from the peacock and other "birds of gayest plume," which are made to distinguish the supposed resemblance. Besides, the finest salmon-fishing is in mild weather during the colder seasons of the year, and in early spring, several months before any dragonfly has become visible on the face of the waters, as it is a summer insect, and rarely makes its appearance in the perfect state till the month of June. If they bear no resemblance to each other in form or colour, how much more unlike must they be, when, instead of being swept down the current, as a real one would be, the artificial fly is seen cross-

ing and recrossing every stream and torrent, with the agility of an otter, and the strength of an alligator? Now, as it is demonstrable that the artificial fly generally used for salmon bears no resemblance, except in size, to any living one; that the only tribe which, from their respective dimensions, it may be supposed to represent, does not exist in the winged state during the period when the imitation is most generally and most successfully practised; and if they did, that their habits and natural powers totally disenable them from being at any time seen under such circumstances as would give a colour to the supposition of the one being ever mistaken for the other; may we not fairly conclude that, in this instance at least, the fish proceed upon other grounds, and are deceived by an appearance of life and motion, rather than by a specific resemblance to any thing which they had previously been in the habit of capturing? What natural insect do the large flies, at which sea-trout rise so readily, resemble? These, as well as gilse and salmon, frequently take the lure far within the bounds of the salt-water mark; and yet naturalists know that no such thing as a salt-water fly exists, or at least has ever been discovered by their researches. Indeed no true insect inhabits the sea. What species are imitated by the palmer, or by three fourths of the dressed flies in common use? An artificial fly can, at the best, be considered only as the representation of a natural one which has been drowned, as it is impossible to imitate the dancing or hovering flight of the real insect over the surface of the stream; and, even with that restricted idea of its resemblance to nature, the likeness must be scarcely perceptible, owing to the difference of motion, and the great variety of directions in which the angler drags his flies, according to the nature and special localities of the current, and the prevailing direction of the wind.

The same observations apply, with almost equally few exceptions, to bait-fishing. The minnow is fastened upon swivels, which cause it to revolve upon its axis with such rapidity, that it loses every vestige of its original appearance; and in angling with the par tail, one of the most killing lures for large trout, the bait consists of the nether half of a small fish, mangled and mis-shapen, and in every point of view divested of its natural form.

Fly-fishing has been compared, though by a somewhat circuitous mode of reasoning, to sculpture. It proceeds upon a few simple principles, and the theory is easily acquired, although it may require long and severe labour to become a great master in the art. Yet it is needless to encompass it with difficulties which have no existence in reality, or to render a subject intricate and confused, which is in itself so plain and unencumbered. In truth, the ideas which at present prevail on the matter degrade it beneath its real dignity and importance. When Plato, speaking of painting, says that it is merely an art of imitation, and that our pleasure arises from the truth and accuracy of the likeness, he is surely wrong; for if it were so, where would be the superiority of the Roman and Bolognese over the Dutch and Flemish schools? So also in regard to fishing: The accomplished angler does not condescend to imitate specifically, and in a servile manner, the detail of things; he attends, or ought to attend, only to the great and invariable ideas which are inherent in universal nature. He throws his fly lightly and with elegance on the surface of the glittering waters, because he knows that an insect with outspread gauzy wings would so fall; but he does not imitate (or if he does so, his practice proceeds upon an erroneous principle), either in the air or on his favourite element, the flight or the motion of a particular species, because he also knows that trouts are much less conversant in entomology than M. Latreille, and that their omnivorous propensities induce them, when inclined for food, to rise with equal eagerness at every minute thing which creepeth upon the earth or swimmeth in the waters. On this fact he generalizes,—and this is the philosophy of fishing.

We are therefore of opinion that all, or a great proportion, of what has been so often and sometimes so well said about the great variety of flies necessary to an angler, —about the necessity of changing his tackle according to each particular month throughout the season,—about one fly being adapted solely to the morning, another to noonday, and a third to the evening,—and about every river having its own particular flies, &c. is, if not erroneous, at least exaggerated and misconceived. That determinate relations exist between flies of a certain colour and particular conditions of a river, is, we doubt not, true; but these are rather connected with angling as an artificial science, and have but little to do with any analogous relations in nature. The great object, by whatever means it is to be accomplished, is to render the fly deceptive; and this, in fact, we believe to be more frequently effected when fishing with flies which differ in colour and general appearance from those which are upon the water. When a particular fly prevails upon a river, an artificial one in imitation of it will never resemble it so closely as to appear the same to those below (*i. e.* the fish): on the contrary, a certain degree of resemblance, without any thing like an exact similitude, will only render the finny tribe the more cautious through suspicion; while a different shape and colour, by exciting no minute or invidious comparisons, would probably have been swallowed without examination. Indeed, it seems sufficiently plain, that where means of comparison are allowed, and where exact imitation is at the same time impossible, it is much better to have recourse to a general idea, than to an awkward and bungling individual representation. How often has it been asserted, with all the gravity of sententious wisdom, that the true mode of proceeding in fly-fishing is to busk your hook by the river-side, after beating the shrubs to see what colour of insect prevails. A very expert angler, who perhaps carried the opposite theory rather too far (although he always filled his pannier), was in the habit of stirring the briars and willows to ascertain what manner of fly was not there, and with that he tempted the fishes.

It is admitted, that during mid-summer, when the weather is calm, the sky clear, and the river low, and when what is called fine fishing is necessary, a close imitation both of the appearance and motions of the natural fly may frequently be tried with advantage; in which case the tackle may be allowed to drop gently down the stream: but it more usually happens, from the style of fishing practised during the vernal and autumnal states of a river, that the hook is not deceptive from its appearing like a winged fly which has fallen from its native element, but from its motion and aspect resembling that of some aquatic insect. When the end of the line first falls on the surface of the water, the fish may be deceived by the idea of a natural fly; and it is on that account that the angler should throw his tackle lightly and with accuracy, and it is on that account also that we would advise the more frequent throwing of the line: but so soon as the practitioner begins to describe his semicircle across the river, the character of the lure is changed, and the trout then seizes the bait, not as a drowning insect, but as a creature inhabiting its own element, which had ventured too far from the protection of the shallow shore or the sedgy bank. That this is the case, a subsidiary argument may also be drawn from the fact, that in most rivers the greater number and the finest fish are generally killed by

the drag-fly, which, during the process of angling, swims an inch or two under water.

Nevertheless, as these opinions of ours may not accord with the practice of other anglers, we shall proceed somewhat more methodically to explain a few of the principles of the art as usually received and followed.

The great secret in fly-fishing, after a person has acquired the art of throwing a long and a light line, is perseverance,—that is, constant and continuous exertion. Fish are whimsical creatures, even when the angler, with all appliances and means to boot, is placed apparently under the most favourable circumstances. Let him, however, commence his operations with flies which, upon general principles, he knows to be good,—for example, a water-mouse body and dark wing, hare-ear and moorfowl wing, red hackle and teal or mallard wing. It may frequently happen that for an hour, or even two hours, he will kill nothing; but then it will as often happen that for another couple of hours he will pull them ashore with a most pleasing celerity.

Awake but one, and, lo, what myriads rise!

Next comes a pause of another hour or more, during which little or nothing is obtained, so that if the intermediate period is frittered away, success is doubtful or impossible. We believe that the appetites and motions of the finny tribes are regulated and directed by certain (to us) almost imperceptible changes in the state of the atmosphere, with which, as they do not proceed from any determinate or ascertained principles of meteorological science, it is not easy for the angler to become acquainted; and therefore the only method to remedy the *désagrément* thus arising, is to fish without ceasing as long as he remains by the " pure element of waters." The art of angling, if worthily followed, and with an observant eye, will probably one day or other be the means of throwing considerable light on the science of electricity, at present one of the most obscure, though at the same time the most important and influential, of all the subjects of physical learning.

The best *natural* flies, either to use fresh, or to serve as models for the artificial kinds, are, *first*, the different sorts of stoneflies (*Phryganea* and *Limnephilus*), which are usually found by the water-side. Their common colours are various shades of brown; they have pretty long feelers or antennæ, which, in a state of repose, are bent over their shoulders and along their sides; their wings are held decumbent, or close to the sides. They fly heavily, and are produced from aquatic larvæ called caddis or case-worms, remarkable for their curious dwelling-places, which are hollow tubes composed of sand, small shells, and pieces of wood, agglutinated together, and made heavier or lighter, according to circumstances, that they may the more easily sink or swim. They are open at either end, and the worm crawls along the stones and gravel, by protruding its legs at the anterior extremity. They disencumber themselves from their aquatic habitations, and assume the winged state in spring and the earlier part of summer. *Secondly*, The different kinds of May flies (*Ephemeræ*), called green drakes, &c. are also produced from larvæ, which, for a long time previous to their appearance as perfect insects, have inhabited the waters. There are many species of this genus, all of which are greedily sought for by trout. They are easily known by their tapering abdomens, veined wings, short antennæ, and the long slender setæ or hairs which terminate their bodies. They chiefly abound from May to mid-summer. *Thirdly*, The small black or ant-fly, is the winged female of the common black ant, and occurs in the nests or hills of that insect during the summer and autumnal months.

There is scarcely any season of the year, excepting the winter months, in which an experienced angler may not successfully ply his trade.[1] In the mid-summer season, when the pools are very clear and shallow, and the streams almost dried up, little can be done without a stirring breeze; so also after a heavy summer flood, immediately ensuing a continuance of dry weather, when the mountain torrents are a sheet of dingy foam, and the crystal depths of the river are converted for a time into an opaque flow of muddy water, the fly-fisher's occupation's gone. But when the turmoil ceases, and the soft south wind begins to disperse or break in upon the dense array of clouds, so as to chequer the streams, and rocks, and " pastoral melancholy" of the green mountains with the enlivening beams of the returning sun, with what pleasure does the angler approach the banks of a favourite and accustomed river! How various and delightful are his sensations! Custom cannot stale their infinite variety:—on the contrary, the longer and more assiduously the pleasure is pursued, the greater the immediate enjoyment, and the more extended the train of agreeable remembrances for after-days. How exciting the first cast into a breeze-ruffled pool, when the unwetted gut still lies in rebellious and unyielding circles on the surface, and yet almost at the same moment the sounding reel gives notice that these circles have been instantaneously stretched into a straight and tightened line! Then comes the long and continuous vibration of rod and reel, indicating the secure hooking of a goodly fish; or that sullen and pulse-like tug, by which a still goodlier one, when hooked in a deep pool, frequently manifests a desire to *dig* its way to the bottom; or that more interrupted music which results from the fantastic leaps of some whimsical individual, which skims and flounders on the top of the water like a juvenile wild-duck.

The ordinary rules for fly-fishing are, to be most assiduous when the streams are somewhat disturbed and increased by rain,—when the day is cloudy, and the waters moved by a gentle breeze, especially from the south. If the river contains long placid pools, then a steady stirring breeze is very desirable, as angling in such situations resembles lake-fishing, where nothing can be achieved upon a glassy surface. If the wind is low and the weather clear, of course the best angling is in the swiftest streams, and in those curling and perturbed eddies which head the smoother depths. In fishing the smoother pools of no great depth, be careful that the shadows of neither rod nor angler come upon the surface; but if a person is skilful in other respects, he need not fear his own shadow in a broad river, but wade boldly down the centre of the stream, fishing its various depths and currents before him and on either side. In clear rivers the flies should be small and rather slender-winged; but when the waters are muddy or increased by rain, a larger lure may be

[1] Although Izaak Walton, that " great master in the art of angling," informs us that no man should in honesty catch a trout till the middle of March, yet the grayling is in best condition during the winter season. " I do assure you," says Charles Cotton, in the second part of the Complete Angler, " which I remember by a very remarkable token, I did once take, upon the sixth day of December, one, and only one, of the biggest graylings, and the best in season, that ever I yet saw or tasted; and do usually take trouts too, and with a fly, not only before the middle of this month, but, almost every year, in February, unless it be a very ill spring indeed; and have sometimes in January, so early as new-year's tide, and in frost and snow, taken grayling in a warm sun-shine day for an hour or two about noon; and to fish for him with a grub it is then the best time of all."

made use of. When the streams are brown with rain, an orange-coloured fly is good; in very clear weather a light-coloured one; and a dark fly is advisable for troubled waters.

Though a great deal no doubt depends on a quick eye and an active and delicate hand, we are no great advocates for what is called *striking* a fish. If a large trout rises in a deep pool, it may be of advantage so to do; and this will be sufficiently accomplished by inclining the rod quickly aside, so as to draw out a few inches of the line; for if the reel is not allowed to run, this operation is apt to snap the gut, or otherwise injure the tackle. But if a trout, whether great or small, rises in a current or rapid stream, the sudden change in its position, immediately after it has seized the fly, is generally quite sufficient to fix the barb, without any exertion on the part of the angler.

A variable state of the atmosphere is bad for angling; but neither is a uniformly dull gloomy day the most favourable. It is scarcely possible to lay down any general rules on this branch of the subject. We have half filled a pannier during an electric hail-storm, when "sky lowered and muttered thunder," and the aspect of the day was such as to deter more experienced though less zealous sportsmen from leaving the shelter of their homes. If the river is not too low, we always prefer what in ordinary language might be called a fine cheerful day, more particularly if there is a fresh breeze. And what we would more particularly press upon the notice of the angler, as soon as he becomes master of the line, is, that he should cast his flies more frequently than is the usual practice, and, generally speaking, fish rapidly. This should be more especially attended to in streams where the trout are numerous and not large.

Before enumerating and describing the different kinds of artificial flies in greatest repute, we shall mention a few of the principal materials used by the fly-fisher. The articles which he employs in common with those who prosecute the other branches of the trade, are of course rods, hair and gut lines, reels and hooks, panniers and landing-nets; but in addition to these he must be provided with a great variety of feathers, such as the slender plumes called hackles, from the necks and backs of common poultry, and the wings of a considerable number of birds, such as woodcocks, snipes, rails, plovers, ducks, grouse, partridges, and others. The furs of quadrupeds are also indispensable; and of these the most useful are hares, squirrels, moles, martens, mice, and water-rats.

The most esteemed hackles are the *duns*. The red, striped down the centre with black, and the red with a blackish root, are likewise useful, and more easily obtained. Since the introduction of Spanish poultry (by which name are designated the black breed with white tops), black hackles are now more common than formerly. The proper time for plucking hackles is about Christmas. The feathers of the ostrich and peacock are of frequent service; and for salmon and sea-trout the gaudy plumes of parrots and other brilliantly attired foreign species, however unlike the generality of our northern insects, ought to be collected by every fly-fisher.

The silks commonly used by the angler are of three kinds:—1*st*, Barbers' silk, used double, for splicing the top-pieces of rods; 2*dly*, a more delicate kind, for fastening on the rings through which the reel-line runs; 3*dly*, fine netting silk for whipping hooks and dressing flies. When we mention a pair of small pliers, fine-pointed scissors, needles, and wax, we have noted the principal materials for the angler's trade.

In regard to rods, their length and formation are so much matters of individual taste, that few general rules can be laid down upon the subject. According to Daniel, the wood should be cut about Christmas, and allowed to season for a twelvemonth. Hazel is very generally used, especially that from the *cob-nut*, which grows to a great length, and is for the most part very straight and taper. The but-end should rather exceed an inch in diameter, and the shoots for stocks, middle pieces, and tops, should be as free from knots as possible. The tops are made from the best rush ground shoots. All these pieces should be kept free from moisture till the ensuing autumn, when such as are required to form a rod are selected; and, after being warmed over a gentle fire, they are set as straight as possible, and laid aside for several days. They are then rubbed over, by means of a piece of flannel, with linseed oil, which produces a polish, and brings off the superfluous bark: they are then bound tight to a straight pole, and kept till next spring, by which time they will be seasoned for use. They are then matched together in due proportions, in two, three, or more parts, according to the desired length, or the opinion of the maker as to the number of pieces of which a rod should be composed. A well-constructed spliced rod of no more than two pieces casts a line with fully as much force, neatness, and accuracy as any other; but it is inconvenient to a traveller, or to any one whose dwelling is not close upon a stream. If the pieces are not ferruled, they must be spliced so as to join each other with great exactness. The principal object to be kept in view in the formation of rods in general is, that they should taper gradually and bend regularly. A frequent defect is their bending too much in the middle, owing to that part not being sufficiently strong.

We have said that the length of a rod is rather a matter of taste than of established rule. It must, however, bear a relation to the size of the river and the nature of the expected capture. A trouting rod is usually made from 12 to 14 feet in length, though some prefer them of greater extent, as giving more command over lakes and spreading pools. It should be made as light as is consistent with strength and durability, as a heavy rod is cumbersome, fatiguing, and unwieldy; and a light one gives a more ready power in casting under hollow banks, or among trees or bushes. For pike and barbel a proper length is 16 feet; for perch, chub, bream, carp, eels, and tench, a shorter rod may be used; and 8 or 10 feet is sufficient for dace, gudgeon, ruff, bleak, &c. The portability of a rod depends of course on the number of joints; but its excellence being almost in the inverse ratio, care must be taken not to sacrifice its goodness merely for the sake of a convenient form.

According to Mr Bainbridge, the best rods are made from ash, hickery, and lance-wood; ash for the bottom piece, hickery for the middle, and lance-wood for the top-joints. If real bamboo can be procured of good quality, it is preferable to lance-wood. Rose-wood and partridge-wood from the Brazils may also be used for the top-pieces. The extreme length of the top-piece is usually composed of a few inches of whalebone. The rings for the reel-line may be made by twisting a piece of soft brass-wire round a tobacco-pipe, and soldering the ends together. They ought to diminish in size as they are made to approach the top, and must form a straight and regular line with each other when the rod is put up for use.

In finishing a rod the usual varnish is copal varnish, or Indian rubber dissolved over a slow fire in linseed oil. It may be stained by a dilution of nitric acid or oil of vitriol. When rods are stored for the winter, after use, they ought to be rubbed over with tallow or salad oil. As few anglers require to make their own rods, we deem it unnecessary to enter into a full detail of a mechanical practice which can only be sufficiently executed by an individual of pro-

Angling. fessional experience. We shall merely mention, that, in addition to the woods already named, elder, holly, yew, mountain ash, and briar, all of which are indigenous to this country, furnish materials to the makers of rods.

As lines may be purchased from the tackle-makers at a cheaper rate than they can be made by an amateur whose time and labour are of value for any other purpose, we shall not here enter into a detail of their formation. The best hair is procured from the tail of a well-grown stallion. Black hair is generally strong, but the colour is not very serviceable. Transparent and almost colourless hair is the most approved; and it ought to be round, regular, and free from blemishes. In the formation of lines each hair in a link should be equal, round, and even, which proportions the strength and prevents single hairs from breaking, and thus weakening the others. Chesnut or brown-coloured hairs are best for ground angling, especially in muddy water. Some anglers stain their lines a pale green for fishing in weedy waters. Black is occasionally used in streams which flow from mosses, and are themselves of an unusually dingy hue.

The following are some of the methods used by anglers for dyeing their lines, whether of hair or gut.

For a pale watery green.—To a pint of strong ale add half a pound of soot, a small quantity of walnut leaves, and a little powdered alum; boil these materials for half or three quarters of an hour, and when the mixture is cold steep the gut or hair in it for ten or twelve hours.

For a brown.—Boil some powdered alum till it is dissolved; add a pound of walnut-tree bark from the branches when the sap is in them, or from the buds, or the unripe fruit. Let the liquid stand till nearly cool, and skim it; then put in the gut or hair, and stir it round for about a minute, or till it appears to have imbibed the desired tint. It ought not to be strongly tinctured, as it is apt to rot when too dark. For a *bluish watery tint* the above ingredients are also used, with the substitution of logwood instead of walnut.

For a yellow.—The inner bark of a crab-tree boiled in water, with some alum, makes a good yellow, excellent for staining tackle used among decayed weeds, the colour of which it closely resembles.

A tawny hue is obtained by steeping hair among lime and water for four or five hours, and then allowing it to soak for a day in a tan-pit. In the absence of other ingredients, both gut and hair may be easily stained by being left for twenty-four hours in strong tea, either with or without a few log-wood scrapings.

The hair to be dyed ought to be selected from the best white. Silken or hempen lines may be tinted by a decoction of oak bark, which is said to add to the durability of these materials.

We shall now proceed to consider the subject in relation to the different species of fish which form the principal objects of the angler's art.

The Salmon. (*Salmo Salar.*)

As the natural history, classification, and characteristic distinctions of fishes will be given at length under the article ICHTHYOLOGY in this work, we shall not here enter into any description of either the structure or habits of the class, but confine ourselves for the present almost entirely to such points as are most essential to the practical knowledge of the angler.

This fine fish delights in large and rapid rivers. It bites best from six in the morning till eleven in the forenoon, and from three in the afternoon till sunset. A moderate breeze is of advantage; and the best months are March, April, May, and June. The salmon is justly regarded by the angler as the king of fish; and when we consider that they occasionally measure four feet in length, and weigh upwards of 70 pounds, we may conceive how difficult a capture and how valuable a prize they sometimes prove. The most successful bait, as well as the most agreeable in the usage, is the artificial fly. This is made in imitation both of dragonflies and butterflies of various kinds; but the principles which we have already endeavoured to establish at the commencement of this article make it unnecessary to describe the natural species. Even those who most warmly advocate the necessity of imitating existing insects in the formation of their lures, admit that the salmon is so capricious as frequently to rise at an artificial fly which bears no resemblance to any natural form of insect life.

The following are the descriptions of six artificial flies which have been found very successful in raising salmon. No. 1 (see Plate XLI. fig. 1) is recommended as a spring fly, and is composed of the following materials: Wings of the dark mottled brown or blackish feather of a turkey; body of orange camlet mixed with a little mohair; and a dusky red or bright brown cock's hackle, plucked from the back where the fibres are longest, for the legs. The hook should be of the same size as represented in the plate; and it has been observed that all large salmon-flies should be dressed upon two or three lengths of gut twisted together, and that the silk in dressing be brought beyond the shank of the hook, and wrapped four or five times round the gut, so that it may not be speedily cut by the sharpness of the steel.[1] This same fly, dressed with the wings of a somewhat brighter shade, and with the addition of a little gold wire or thread wrapped round the body at equal distances, will also serve for a more advanced season of the year. No. 2 (see Plate XLI. fig. 2) is of smaller size, and may sometimes be dressed upon very strong single gut. Any feather of a coppery or dingy yellow colour, if not too coarse in the fibres, will be suitable for the wings; the body is of lemon-coloured mohair, mixed with a small portion of light brown fur or camlet, with a pale dusky ginger hackle over the whole. The chief object to be attended to in dressing this fly is to produce that uniform hue, devoid of gaudy colouring, from which it has received the name of the *quaker fly*. Of No. 3 (see Plate XLI. fig. 3) the wings are made from the plumes of a cormorant, or from the mottled feathers of a dark mallard: the body is of dark sable, ribbed with gold wire, over which a dusky red hackle is thickly wound: the mottled feathers of a drake are used for the tail; and previous to fastening off, a small portion of flos silk should be unravelled and fastened at the extremity of the hook. This fly, though, like the preceding, of a somewhat sombre cast, is frequently used with success in summer. No. 4 (see Plate XLI. fig. 4) belongs to the gaudy class of lures, "which," says Mr Bainbridge, "however fanciful or varied in shade or materials, will frequently raise fish when all the imitations of nature have proved unsuccessful; indeed so fastidious and whimsical are the salmon at times, that the more brilliant and extravagant the fly, the more certain is the angler of diversion." In this, of course, we perfectly agree. The wings of the fly in question are formed of the extreme end of a Guinea fowl's feather, not stripped, but having the fibres remaining on both sides of the middle stem. A blood-red hackle is fastened on with the wings, and so arranged

[1] Bainbridge's *Fly-Fisher's Guide*, p. 96.

as to extend beyond them: the dyed feathers used by military men will suit, if another showy biped, the scarlet maccaw, is not accessible. The green feather which forms the eye of the peacock's tail should be fastened at the head, and left hanging downwards, so as to cover the body for the space of half an inch; and a few filaments of the same part of the feather may be fastened at the tail. No. 5 has the wings formed from the darkish brown speckled portion of a bittern's wing stripped off from the stem: the head ought to be of the same colours as the body, which is formed of the reddish brown part of a hare's fur, and deep copper-coloured mohair; a bittern's hackle is put over the body for legs, and a forked tail is added, made of a pair of single filaments of the same feather as the wings. Of No. 6 the wings are formed of the mottled feathers of a peacock's wing, intermixed with any fine plain dusky red; the best mixture for the body is the light brown inner hair from a bear's skin, sable fur, and gold-coloured mohair; gold twist, a large black cock's hackle, and a red one a little larger, with a bit of deep red mohair for the head. In addition to these, we might enumerate the brown fly, the blue fly, the king-fisher, the prime dun, the great palmer, the golden pheasant, the gray mallard, and many others; but such as are above described will suffice for the purposes of the present treatise. Fig. 6 of Plate XLI. represents an excellent spring fly; and an approved summer kind is shown on the same plate, fig. 5.

It may be stated at once, that so far from imitating nature, the maker of salmon flies can scarcely form them in too unnatural and extravagant a manner. Let him call in the aid of fancy at all times and places, at least in this country; for the cold and cloudy clime of Scotland assuredly furnishes nothing resembling the lures most frequently and most successfully used. The superabundant use of gold and silver wire ought, however, to be avoided, as it not only causes the fly to sink too much in the water, but prevents its being neatly or lightly thrown. Spring flies for salmon are usually made of a larger size, though not so gaudily dressed as those of summer.

A salmon rod is generally proportioned to the size of the river which the angler frequents; but it ought not to be less than 15 feet in length. The reel ought to be large enough to contain 80 or 90 yards, so as to admit of abundance of line being given out when required; for many fish, when struck, run out to a great distance, and with such immense rapidity as to prevent the possibility of the angler's moving in the proper direction with sufficient quickness. A salmon, for the most part, darts violently up the stream; and, as the command and direction of the fish is more easily kept with a short than a long line, it is advisable to prevent his getting too far ahead, by keeping the rod well back in the opposite direction, and by running towards him along the margin of the stream. When he gains the head of the current, a salmon frequently throws himself several times out of the water, on which occasions the angler must yield him freely a little of the line; but during his general and less violent manœuvring, he will of course be the sooner exhausted the more firmly he is held. When he appears to be making for some safe haunt or secret sheltering place, the great object is to turn him towards safer ground, either by relying on the soundness of the tackle, or, if he proves very powerful as well as very obstinate, then a pebble or two may be thrown, so as to fall a little in advance of his position, and he will probably turn himself round. Some fish become very sulky, and will lie after being hooked, for a long time, motionless near the bottom. In this case also the pebbles must be had recourse to; for the more a fish is kept in motion, the sooner he becomes exhausted. When he begins to show his side, and exhibits other unequivocal symptoms of exhaustion, a favourable landing-place should be looked for; and when the proper time arrives, which can only be learned by the (sometimes dearly bought) lessons of experience, then is he to be drawn by degrees to the gravel bank, or the gaff applied, and the prize secured.

When feeding, salmon are usually found at the foot of a strong stream, terminating in an eddy or whirlpool. "And first," says our father Walton, "you shall observe that usually he stays not long in a place, as trouts will, but, as I said, covets still to go nearer the spring-head."

When the water is either too much discoloured for the use of the artificial fly, or, running into the opposite extreme, becomes (especially in very still weather) too clear and bright, salmon may be successfully angled for with the worm. In this case trolling tackle is sometimes used.

In trolling with minnow or other small fish, the foot lengths ought to be about three yards long, and furnished with one or two swivels, to prevent the line from twisting, as well as to enable the bait to play freely. A lead or shot proportioned to the strength of the stream should be fastened to the line, about a foot above the bait. The top of the rod should be stiffer than that used for fly-fishing; and when the hook is baited, it ought to be thrown first across, and then drawn up the stream.

The spawning process, with salmon, commences late in autumn, and continues through the winter months, the exact period varying with the sexual condition of individual pairs. The ova are hatched after the lapse of from 90 to 120 days, the period depending on the temperature of the stream; that temperature varying according to the locality, or the character of the season. The young usually remain in their native river (under the name of *par*) for a couple of years, after which they are transmuted into *smolts*,—small fishes of a silvery hue, with but slight vestiges of the coloured spots and bars by which they had been previously characterised. In this state they make their way in spring into the sea, where the rapidity of their growth is extraordinary, and has not yet been explained or accounted for. In a few months (sometimes even in a few weeks) they again seek their native streams, having, during a very short sojourn in the sea, increased from the weight of a few ounces to that of several pounds. Without discussing the distinctions of salmon trout, whitlings, grilse, and salmon, suffice it here to say, that all these migratory fish, usually characterised by their small number of spots, their silvery colour, and the superiority of their flesh, may be angled for with much larger and more gaudily plumed flies than those used in the capture of river-trout.

The Common Fresh-water or River Trout. (*Salmo Fario.*)

This species varies greatly in size and colour, in accordance probably with the nature and abundance of its food, the strength and depth of the river in which it occurs, and the physical properties of soil and climate. Fish seem, more than most animals, to depend on peculiar and unappreciable circumstances, for the full and characteristic development of their characters; and they consequently exhibit great contrariety of aspect among individuals of the same species. If a canal or reservoir, or any other great accumulation of water, is formed by the hand of man, where the hand of nature had from time immemorial recognised only some small and solitary streamlet, the lapse of even a few months produces large and heavy fish, where none but trouts of the most trifling size had ever been seen before. The writer of these observations kept a minnow little more than half an inch long in a glass tumbler for a period of two years, during which time there was no perceptible increase in its dimensions.

Had it continued in its native stream, subjected to the fattening influence of a continuous flow of water, and a consequent increase in the quantity and variety of its food, its cubic dimensions would probably have been 20 times greater; yet it must have attained, prior to the lapse of a couple of years, to the usual period of the adult state. In regard to birds and quadrupeds, the individuals of the same species are not distinguishable from each other by any peculiarities either of form or colour, at least within the limits of a restricted locality; but it appears to be otherwise with several species of fish, more especially trouts. Those of the Clyde and Tweed, although both rivers draw their primary sources almost from the same mountain, present a constant and well-marked difference in their external aspect; and a corresponding dissimilarity exists among the characteristic varieties of almost every river and lake in Scotland; " which I tell you that you may the better believe that I am certain, if I catch a trout in one meadow he shall be white and faint, and very like to be lousy; and as certainly, if I catch a trout in the next meadow, he shall be strong, and red, and lusty, and much better meat. Trust me, scholar, I have caught many a trout in a particular meadow, that the very shape and the enamelled colour of him hath been such as hath joyed me to look on him; and I have then with much pleasure concluded with Solomon, ' Every thing is beautiful in his season.' "[1]

No fish affords the angler more varied or more constant sport than the trout. For nine months in the year, under favourable circumstances, fly-fishing may be practised for it with success. Westerly and southerly winds are the most favourable, especially in spring; but during warm and cloudy summer weather, the point from which the wind blows is of slight consequence. " He who considers the wind," says Solomon, " will never sow;" and the same remark is not inapplicable to angling. Whoever desires to become a successful practitioner in the art, must angle in all weathers, and under every variety of circumstances, however unpropitious the prospect may be. Trout are generally supposed to rise more freely during a dark and lowering day, following a clear bright night, as brilliant moonshine detains them in their lurking-places; and on the ensuing day they are consequently more inclined for food. On the other hand, after a gloomy or darkish night they are less easily tempted, having glutted themselves with moths and other nocturnal insects, which, during the summer months, are abundant on the waters. In throwing the line the angler should endeavour to make his gear fall as lightly as possible on the surface, and his flies should drop opposite, or somewhat above his own position, and then be played gently and neatly downwards and across the stream. When a trout is seen to rise at a natural fly or other insect, the artificial one should be offered him by being thrown, not directly over him, but about a yard higher up the stream; and, if he is inclined to rise again, he will probably meet it half-way. When a fish, on being hooked, descends beneath the surface, and struggles in the depths below, it is a pretty sure sign that he is well secured; but when he flounders on the surface, or leaps occasionally into the air, more care is necessary, as in that case the hook will frequently be found to be only skin-deep. In playing and landing a large trout the same precautions are necessary as in salmon-fishing, although in regard to smaller fish, if the angler is standing in the centre of a stream, and finds it inconvenient to wade frequently ashore, a few additional turns will exhaust the capture, which may then be drawn rapidly and steadily to the hand, and secured by a firm grasp behind the gills. We have frequently practised a summary method of landing even tolerably sized fish; which, though it cannot always be effected, is, when possible, a great saving of time. If, from the moment the trout is struck, he is prevented from redescending in such a manner that the upper part of his head and eyes are retained above or on a level with the surface, he will for the space of a good many seconds be so much astonished as to be incapable of any active exertions, and will frequently allow himself to be drawn in that position, and without resistance, straight ashore.

The following flies are in repute among anglers. The *black gnat* appears about the end of April. The body is formed of a black strip from an ostrich feather, and ought to be dressed thick and short; the wings of a pale starling's feather, or dressed as a hackle with a pale dun.

The *March brown* or *dun drake* is frequently visible by the middle of March. The wings are made from the mottled feathers of a partridge's tail, and the body of hare-ear fur, intermixed with a little yellow worsted; a grizzled hackle for legs.

The *hazel fly* is of a round form, and difficult of imitation. It is a killing fly in May and June, especially where bushes abound. The body is composed of ostrich harl of two colours, black and purple twisted together; the wings of the sandy-coloured feathers from under the wings of a thrush, or the reddish plumes of a partridge's tail; a bluish hackle, twisted pretty full, serves both for the under wings and legs.

The *great dark dun*, according to Mr Bainbridge, is one of the earliest flies which appear upon the water, and may be used in February, if the weather is mild. The wings are formed from the dun feathers of a mallard's wing; the body of mole-fur, mixed with a little dark brown mohair; a dark grizzled hackle for legs. Salmon frequently rise at this fly, which may be used with success early in the morning during the whole fishing season.

The *wren's tail* has no wings: the body is of sable fur, with a little gold-coloured mohair, and a feather from the tail of a wren.

The *grouse hackle* is also wingless: the mixture for the body is dark olive, dusky yellow, and a little gold-coloured mohair. It is formed of a fine mottled grouse's feather of a reddish brown, running a little dusky towards the butt-end of the stem, and the downy portion, if any, plucked away.

The *stonefly* is found along the edges of streams, and is a favourite article of food among trout. It is a species of Phryganea, and springs from a caddis or aquatic larva. The wings lie flat, and are imitated by the mottled feather of a hen-pheasant or peahen. The body is composed of dark brown fur from a bear's skin, or the deeper part of a hare's ear, mixed with yellow camlet or mohair; a longish grizzled hackle is wrapped under the wings.

The *mealy brown* or *fern fly* is excellent for grayling in May. Its wings should be formed from the under part of a throstle or fieldfare's wing, especially from such feathers as have a yellowish tinge. Its body is of a dusky orange, from the light brown fur of a fox's breast, with a pale dun hackle for legs.

The *orange fly* has four wings made of the blue feather of a mallard-teal. The head is of the dark fur from a hare's ear; the body gold-coloured mohair mixed with orange-camlet and brown fur, a small blue cock's hackle for legs. This is said to be an alluring fly to young salmon.

[1] Walton's *Complete Angler*, p. 128, edit. 1823.

The *hare's ear* is chiefly used as a drop-fly. The wings are from the light part of a starling's wing feather, and the body of dark hare-ear fur. According to Daniel, when the streams are deep, the same body winged with a rail-wing's feather and a red hackle is very killing during the summer season.

The *yellow dun* is used in the morning and evening during the months of April and May, and again in September. The body is made of yellow yarn unravelled, or with marten's fur, and mixed with a little pale ash-coloured fox-cub fur; the wings are formed upright, from the under part of a snipe's wing, with a pale dun hackle for legs.

The *hawthorn fly* is in use from the middle of April to the end of May, from ten o'clock till three. It has transparent wings, which may be imitated with the palest feather of a snipe or mallard's wing; horn shavings, or the membranous substance found in the core of an apple, serve the same purpose; the body is of black ostrich harl, with a black hackle for legs.

The *summer dun* has a thicker form than most of the dun flies, and is dressed upon a short-shanked hook. Mole-fur ribbed with ash-coloured silk is employed for the body; the wings are from the wood-pigeon, with an ash-coloured hackle for legs.

The *black-hackle fly* is an approved lure during warm weather, early in a summer morning. The body is formed of a thin-dressed ostrich harl, cut close; the wings, four in number, are from the pale feather of the starling's wing.

The *red spinner* is used as a dropper. The wings are formed of the grayish feather of a drake, tinged with reddish yellow; the body a red hackle, with a twist of gold. This fly is eagerly taken by chub in the evenings of July.

The *little yellow May* or *willow fly* resembles the green drake, on a small scale. The body is formed of yellow fur from the marten's neck, or of yellow worsted unravelled, and mixed with a very small portion of hare-ear fur; the wings are of mallard's feather dyed yellow. This fly appears early in May, and may be used till the appearance of the green drake, of which it is the usual precursor.

The *brown dun* is made of otter's fur mixed with lemon-coloured mohair; the wings are from the fieldfare, with a ginger hackle for legs. This is an excellent fly towards the approach of twilight.

The *green drake* or *May fly* appears about the second or third week of May, and continues about a month. The body is made of hog's down, or light bear's hair, intermixed with yellow mohair; or of barbers' yellow silk only, warped with pale flos silk, and a small strip of peacock's harl for the head: a bittern's hackle is the best imitation of the legs and dark stripes of the body; with the long hairs of the sable or polecat for the tail. The rayed feathers of a wild mallard, dyed of a greenish yellow, suffice for wings.

The *blue blow* is a very small fly used during the summer months, and for the first fortnight in August. It is made of a lapwing's top, or any dark blue fur, dressed on a very small hook. The wings are of thistle-down or bluish-white hackle.

The *black midge* is also a small species, the body of which is dressed with brownish-black silk, and a blue cock's hackle. It is taken freely after a shower in the summer evenings.

The *gray drake* follows the green of the same name, although they sometimes occur together. It is an excellent afternoon fly for large trouts. The body is formed of a dirty-white ostrich harl, dressed with flesh-coloured silk, and ribbed with a dark-grizzled cock's hackle; the head is made of peacock's harl, like that of the green drake; the wings from a mottled mallard feather, or that of a mallard-teal, and the tail of sable or polecat's hair.

The *cinnamon fly* has four wings, large in proportion to the body. They are made from the pale reddish-brown feathers of a hen, dressed full; the body of dark brown fur, with a ginger hackle for legs. This fly, according to Mr Bainbridge, is excellent for the Welsh rivers during the months of August and September.

The *sand fly* forms an excellent lure, and may be very generally used from April to September. The wings are formed from the sandy-coloured feathers of the landrail's wing, with a ginger hackle for legs; and the bright sandy-coloured fur from the neck of a hare, mixed with a little orange mohair for the body. If dressed as a hackle, the feathers from under the thrush's wing resemble the natural hue of the wings of the insect.

The *great black ant* makes its appearance in sultry weather, from the middle of June to the latter end of August. The wings are made of the pale-blue feathers from beneath a snipe's wing, or from a tomtit's tail. The body is of black ostrich harl, made thick towards the tail and beneath the but of the wings; the legs of a reddish-brown hackle.

The *great red ant* is nearly contemporaneous with the preceding, which it resembles in size and form. The wings are made of a light starling's feathers; the body of gold-coloured mohair, or copper-coloured peacock's harl, with a ginger hackle for legs.

Among the preceding flies will be found some which will assuredly suit for any river, or for any period of the fishing season. The angler who places implicit confidence in the generally received opinion, that in every stream, and at each season, there is one particular fly in much more special request than any other, will do well to prepare for an unknown river, by making ready a couple of lines, each with three flies all of different kinds. For example, a March brown at the end of the line, a dun hackle, with a lighter or darker body to suit the weather or complexion of the stream, for the first dropper, and a red hackle with peacock body for the second dropper; or, *2dly*, a sand fly at the end, with a grouse hackle or wren's tail, with orange body, for the first dropper; and a pale yellow or cream-coloured hackle over a bluish body, or one of the ant flies, as the second dropper. These are promising flies for most seasons of the year, though, like the others, they require to be changed according to the circumstances of time and place, or the varying caprices of the finny tribes.

As night fishing is a favourite amusement with many anglers, we shall describe a few of the flies in most repute for the practice of nocturnal sport.

The *white moth*, with wings made from the feathers of a white owl, the body of white ostrich harl, with a white cock's hackle over it.

The *brown moth* is winged from the feathers of a brown owl, or the back feathers of a brown hen; the body is of dark bear's hair, covered with a brown cock's hackle.

The *mealy cream* is made from the tawny feathers of a white owl for the wings, with some soft fur of the same colour, and a pale yellow hackle for the body.

The following selection has been recommended by an experienced angler, in relation to the alleged succession of flies during several of the principal months of the fishing season. *1st*, For March, a dun fly, made of dun wool, and the feathers of a partridge wing; or the body made of black wool, and the feathers of a black drake: *2d*, For April, a stonefly, the body made of dark wool, dyed yellow under the wings and tail: *3d*, For the beginning of May, a ruddy fly, made of red wool, and bound about

with black silk, with the feathers of a black cock hanging dangling on his sides next his tail: 4*th*, For June, a greenish fly, the body made of black wool, with a yellow list on either side, the wings taken off the wing of a buzzard, bound with black broken hemp: 5*th*, The moorish fly, the body made of dusky wool, and the wings of the blackish mail of a drake: 6*th*, The tawny fly, in great repute till the middle of June; the body made of tawny wool, the wings contrary, one against another, composed of the whitish mail of a white drake: 7*th*, For July, the wasp fly, the body made of black wool, cast about with yellow silk, and the wings of drakes' feathers: 8*th*, The steel fly, approved in the middle of July; the body made with greenish wool, cast about with the feathers of a peacock's tail, and the wings made of those of a buzzard: 9*th*, For August, the drake fly, the body made with black wool cast about with black silk, the wings of the mail of a black drake, with a black head.

When rivers are very low and clear, from a long continuance of summer drought, it has been recommended to use a pair of wings made from the feather of a landrail, or the mottled feather of a teal, with a well-cleaned gentle fixed upon the hook. During a similar condition of the water, even when no wind is stirring, and the sun shining in its greatest lustre, trouts may be taken with a small *wren's tail*, *grouse*, *smoky dun*, or *black hackles*, the angler fishing straight down the water, by the sides of streams and banks, and keeping well out of sight, with as long a line as can be neatly managed, and the foot-lengths very fine. At these times the fish may be often seen with their dorsal fins above water, and with skilful management may be made to snap at the above-named flies. When one is hooked, the rest dart off; but if the angler keeps concealed, they will return again in a very short time; and thus several fish may be taken even in summer from the clearest pools. Another plan has also been recommended as likely to prove successful when the weather is bright and the water low: Take a line of about a yard in length, and fix it to a short, stiff rod, and having baited the hook with a natural fly, such as the stonefly, or the gray or green drake (Ephemeræ), drop it between bushes over steep hollow banks, or under the projecting roots of trees.

In fishing a river with which the angler has no previous acquaintance, the most approved practice is to try the eddies which are frequent at the corners of streams, and where the circular movement of the current throws out a frequent sustenance for the finny race. There the larger trout often lie; and it must consist with the experience of every angler, that an excellent capture is sometimes made repeatedly from some small spot behind or beside a particular stone, where from day to day one well-sized fish seems to succeed another in the favourite feeding ground. In this knowledge of peculiar localities consists the chief advantage of a previous acquaintance with the water. The smaller fish are found in most abundance in the widely spread and shallow streams, as well as in the extended parts of pools of no great depth. As a general rule, the angler may be advised to fish with the wind on his back and the sun in front, which not only gives him a greater command of his line, but prevents himself or his shadow from being so distinctly perceived. A strict adherence, however, to this plan is by no means advisable, as the angler's position in relation to sun and wind must frequently vary with the natural course of the river, the obstruction of overhanging wood, and the greater or less command of pool and stream presented by the varying form of the adjoining shore.

As *bait-fishing* for trout, though regularly followed by some, is less generally admired and practised than the more elegant use of the artificial fly, fewer words will suffice. When the streams are swollen and discoloured, fine trout may be taken with a running line without float, and so leaded that it shall touch the ground without resisting the force of the stream. The lead should be fixed about eight or ten inches above the hook; and the best baits are well-scoured earthworms. The dew, the garden, and the lob worms are one and the same in species, although they vary considerably in form, size, and colour, according to age, and season, and the nature of the soils. The lobworm, according to Daniel, is of two sorts, the old, *knotted*, the young, without knots, which some for distinction call *maiden lobs*, and others *red* worms. The latter kind, with a red head, a streak down the back, and a broad tail, are the most esteemed. By some they are called squirrel-tails. These and other worms, it need scarcely be observed, are easily obtained in fields and gardens, especially where there has been any recent mixture of vegetable or animal remains. They may be preserved for a considerable period, and even improved in their texture and condition, by being kept in damp moss, changed from time to time, and occasionally wetted with a little new milk. In dry weather, when worms are difficult to be obtained, they may be procured by emptying a few buckets of water in situations where they were known to occur during a moister season. The brandling worm is streaked from head to tail in alternate circles of a red and yellow hue, and is darker at its anterior than posterior portion. They occur in old dunghills, in heaps of rich vegetable mould, and among rotten tan bark. They have this advantage over the others, that they may be used without preparation or scouring. Though the choice of worms does not seem a very suitable subject for poetry, it has been thus versified by Mr Gay in the *Rural Sports*:

> You must not every worm promiscuous use,
> Judgment will tell thee proper baits to choose:
> The worm that draws a long immod'rate size,
> The trout abhors, and the rank morsel flies;
> And if too small, the naked fraud's in sight,
> And fear forbids, while hunger does invite.
> Those baits will best reward the fisher's pains,
> Whose polish'd tails a shining yellow stains;
> Cleanse them from filth, to give a tempting gloss
> Cherish the sullied reptile race with moss;
> Amid the verdant bed they twine, they toil,
> And from their bodies wipe their native soil.

The preceding rhymes apply chiefly to the kind called gilt-tails. *Gentles* are the larvæ of different kinds of carnivorous winged flies. They may be kept in a mixture of oatmeal and bran, and are readily produced in a piece of liver, or any other flesh or fish, exposed in an earthen vessel to prevent their escape when grown to a proper size. All kinds of maggots, as well as those called gentles, serve admirably for the more delicate kinds of bait-fishing. The caddis worms, before alluded to as the larvæ of the Phryganea or stonefly, when taken out of their cases, are a favourite bait for trout; and different kinds of grasshoppers are likewise used with great success. The creeper or water cricket, an aquatic larva, found under stones within the water-mark, ought also to be attended to by the natural bait-fisher.

The palmer worms or wool beds are the hairy caterpillars of certain nocturnal moths. Though refused by almost all birds except the cuckoo, they are swallowed by trouts, and may be preserved alive for many weeks in a box with damp earth, strewed over with the leaves of the tree or bush on which the species was observed naturally to feed.

The young brood of wasps and bees are useful to the angler; and for eight or ten days after their first appearance in summer there is no better or more killing bait

than a small reddish beetle called the *bracken clock* in the north of England, the *Melolontha horticola* of naturalists. Salmon roe is greatly lauded by Barker, who appears to have been the first to discover its merits. "I have found an experience of late which you may angle with, and take great store of this kind of fish. First, it is the best bait for trout that I have seen in all my time, and will take great store, and not fail if they be there. Secondly, it is a special bait for dace or dare, good for chub, or bottlin, or grayling. The bait is a roe of a salmon or trout. If it be a large trout, that the spawns be any thing great, you must angle for the trout with this bait as you angle with the brandling, taking a pair of scissors and cut so much as a large hazel-nut, and bait your hook; so fall to your sport,—there is no doubt of pleasure. If I had known it but twenty years ago, I would have gained a hundred pounds only with that bait: I am bound in duty to divulge it to your honour, and not to carry it to my grave with me. I do desire that men of quality should have it, that delight in that pleasure. The greedy angler will murmur at me, but for that I care not."

Many kinds of pastes are prized by the bait-fisher. They may be used for chub, carp, and bream in September and during all the winter months, and may be made up about the size of a hazel-nut; if for roach and dace, the bigness of a pea will suffice. All pastes are improved by being mixed up in the making with a little cotton wool, which makes them firmer and more tenacious, and hang better on the hook. They suit well for fishing in quiet places, with a small hook and quill float. We shall here subjoin a few recipes for the making of fishing pastes, which, although we introduce them under the head of the river-trout, may be regarded as equally efficacious in the capture of other kinds of fish.[1]

Minnow-fishing for trout is a favourite pastime with many anglers, and the process is one by which very large fish are frequently captured. The tackle used resembles that for salmon, but is lighter and finer, with a single line of gut at the bottom. The hooks vary in size according to the general dimensions of the trout angled for; and the middle-sized and whitest minnows are the most esteemed. The following were Walton's directions for baiting, with a view to this department of the sport. Put your hook in at his mouth and out at his gill; then having drawn your hook two or three inches beyond or through his gill, put it again into his mouth, and the point and beard out at his tail, and then tie the hook and his tail about very neatly with a white thread, which will make it the apter to turn quick in the water: that done, pull back that part of your line which was slack when you did put your hook into the minnow the second time; I say, says Walton, pull that part of your line back so that it shall fasten the head, so that the body of the minnow shall be almost straight on your hook: this done, try how it will turn by drawing it across the water or against a stream; and if it do not turn nimbly, then turn the tail a little to the right or left hand, and try again, till it turn quick. We may add, that the practice of fishing with the artificial minnow is justly discarded by all judicious anglers. For representations of the minnow tackle, and hooks baited, see Plate XLI., fig. 12, 13, and 19.

The Great Lake Trout. (Salmo Ferox.)[2]

It appears that the gray or great trout of the British fresh-water lakes, though never described or characterized as a distinct species, has at various times excited the attention of ichthyologists. Trout of enormous dimensions are mentioned by Pennant as occurring in the Welsh lakes; and Donovan gives Loch Neagh in Ireland as another locality. Very large trout have been killed in Ullswater in Cumberland, and still larger in Loch Awe in Argyllshire. The late Mr Morrison of Glasgow claimed the merit of discovering these fish in the last-named locality about 60 years ago; and the largest recorded to have been killed there weighed 25 pounds. Mr Lascelles, a Liverpool gentleman, has also of late years been equally assiduous and successful in their capture; and it appears that any persevering sportsman is almost certain, with the proper tackle, to obtain specimens in Loch Awe, of this great fish, weighing from 6 to 12 pounds. The largest we have lately heard of weighed 19¼ pounds. It is said to be by far the most powerful of our fresh-water fishes, exceeding the salmon in actual strength, though not in activity. The most general size caught by trolling ranges from 3 to 15 pounds: beyond that weight they are of uncommon occurrence. If hooked upon tackle of mode-

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[1] *Red paste* may be made with a large spoonful of fine wheat-flour, moistened with the white of an egg, and worked with the hands until tough. A small quantity of honey or loaf-sugar finely powdered must be added, together with some cotton-wool spread equally over the paste when pressed flat in the hand; it must be well kneaded, to mix the cotton thoroughly; colour it with a little vermilion. A small piece of fresh butter will prevent it from becoming hard, and it will keep good a week. *White paste* may be composed of the same ingredients, omitting the vermilion; and *yellow paste* in like manner, with the addition of turmeric.

Salmon paste.—Take one pound of salmon-spawn in September or October; boil it about 15 minutes, then beat it in a mortar until sufficiently mixed, with an ounce of salt and a quarter of an ounce of saltpetre; carefully pick out the membrane in which the spawn is contained, as it is disengaged from it; when beat to a proper consistence, put it into gallipots, and cover it over with bladders tied down close, and it will keep good for many months.

Various oils were formerly in great repute among anglers for rubbing over their baits, but as we believe their beneficial effects were entirely imaginary, we shall not occupy our pages by their repetition. A single extract from Izaak Walton will suffice. "And now I shall tell you that which may be called a secret: I have been a-fishing with old Oliver Henley, now with God, a noted fisher both for trout and salmon, and have observed that he would usually take three or four worms out of his bag, and put them into a little box in his pocket, where he would usually let them continue half an hour or more before he would bait his hook with them. I have asked him his reason, and he has replied, 'he did but pick the best out, to be in readiness against he baited his hook the next time.' But he has been observed, both by others and myself, to catch more fish than I or any other body that has ever gone a-fishing with him could do, and especially salmons; and I have been told lately, by one of his most intimate and secret friends, that the box in which he put those worms was anointed with a drop, or two or three, of the oil of ivy-berries made by expression or infusion; and told that by the worms remaining in that box an hour, or a like time, they had incorporated a kind of smell, that was irresistibly attractive, enough to force any fish within the smell of them to bite." We need scarcely remind the reader of the "Complete Angler," that that admirable work is of higher value for the manner in which the subject is discussed, and the beautiful accessories of pure style, poetical sentiment, and picturesque illustration, than for the amount of direct practical information which it conveys. The simplicity and goodness of Izaak Walton's nature seem to have induced a greater degree of credulity than was always consistent with an accurate perception of the truth, and hence every chapter abounds with statements which could not pass current in these more critical days. As a useful work in relation to the mere angler, it cannot be said to hold a high rank, although it must ever delight the general reader, and all who desire to refresh themselves by "the pure well of English undefiled."

[2] We are indebted for the principal materials of the following account of this interesting fish to a manuscript of Sir William Jardine's, with which we have been kindly favoured by the author. It forms part of a series of *Memoirs on British Fishes*, which that assiduous naturalist has been for some time past preparing for the press.

rate strength, they afford excellent sport; but the general method of fishing for them is almost as well adapted for catching sharks as trout; the angler being apparently more anxious to have it in his power to state that he had caught a fish of such a size, than to enjoy the pleasure of the sport itself. However, to the credit of both parties, it may be stated, that the very strongest tackle is sometimes snapped in two by its first tremendous springs. The ordinary method of fishing for this king of trouts is with a powerful rod, from a boat rowing at the rate of from three to four miles an hour, the lure a common trout from four to eight inches in length, baited upon six or eight salmon hooks, tied back to back upon strong gimp, assisted by two swivels, and the wheel-line coarse and strong. Yet all this, in the first impetuous efforts of the fish to regain its liberty, is frequently carried away for ever into the crystal depths of Loch Awe!

When in their highest health and condition, and indeed during the whole of the time in which they are not employed in the operation of spawning, these fish will scarcely ever rise at a fly. At these periods they appear to be almost entirely piscivorous; so, with the exception of night lines, baited also with trout, trolling is the only advisable mode of angling for them. The young, however, rise very freely at ordinary lake-trout flies, and are generally caught in this way from one to one and a half pound weight. They occur abundantly near the outlet of the lake.

These great trout are found in Loch Shin, Loch Assynt, Loch Loyal, and other northern lochs. We have there trolled for them successfully with salted sprats, the bright silvery lustre of which seemed attractive in those dark waters. Their spawning period corresponds to those of salmon, that is, it commences in autumn, and continues through the earlier portion of the winter; and at this time their instinctive tendencies are so far changed, that they will rise eagerly at large and gaudily dressed salmon-flies, and may be either angled for from the banks, or trolled with a cross line. They spawn in rivers, but do not ascend so high as either salmon or sea-trout, and they never descend either into or towards the salt water, although an occasional straggler has been taken in the Awe, at some distance down the river. In Loch Shin, they ascend the streams which flow into the loch, but are not known to enter that which flows from it. When in good season, and in their strongest condition, they appear to roam indiscriminately through every part of the loch, though there are certain spots which may be more depended upon than others, and where an experienced angler will have little difficulty in hooking one of these fine fish. To their great strength we may observe that they add unequalled rapacity; and after attaining to the weight of three or four pounds, they appear to feed almost exclusively on smaller fish, and do not spare even their own young. A small trout of this species, not weighing more than 1½ lb., will often dash at a bait not much inferior to itself in size; and instances are recorded of larger fish following with eager eye, and attempting to seize upon others of their own kind after they had been hooked and were in the act of being landed by the angler. It is probably on account of this strong manifestation of a more than usually predaceous habit, that Sir William Jardine has named the species *salmo ferox*.

When in perfect season, and full-grown, it is a very handsome fish, though the head is always too large and long to be in accordance with our ideas of perfect symmetry in a trout. The body is deep and thickly formed, and all the members seem conducive to the exercise of great strength. The colours are deep purplish brown on the upper parts, changing into reddish gray, and thence into fine orange-yellow on the breast and belly. The whole body, when the fish is newly caught, appears as if glazed over with a thin tint of rich lake-colour, which fades away as the fish dies, and so rapidly, that the progressive changes of colour are easily perceived by an attentive eye. The gill-covers are marked with large dark spots; and the whole body is covered with markings of different sizes, and varying in amount in different individuals. In some these markings are few, scattered, and of a large size; in others they are thickly set, and of smaller dimensions. Each spot is surrounded by a paler ring, which sometimes assumes a reddish hue; and the spots become more distant from each other as they descend beneath the lateral line. The lower parts of these fish are spotless. All the fins are broad, muscular, and extremely powerful; and it is from the number of their bony rays that the specific characters which distinguish this species from the common trout (*salmo fario*) are the most easily and accurately evolved. The dorsal fin is of the same colour with the upper part of the fish; it is marked with large dark spots, and contains fifteen rays, which number exceeds by three that which characterizes the common trout. The caudal fin is much larger and more fleshy. The pectoral, ventral, and anal fins, are very muscular on their anterior edges, and of a rich yellowish-green colour, darker towards their extremities. They contain respectively 14, 10, and 12 rays, whereas the numbers in the corresponding fins of the common trout are 13, 9, and 11. The tail is remarkable for its breadth and consequent power. In adults it is perfectly square, or might even be described as slightly rounded at its extremity: in the young it is slightly forked, and appears to fill up gradually as the fish advances in age. In the common trout, on the contrary, the forked shape of the tail is a permanent characteristic.

The flavour of this great lacustrine species is coarse and indifferent. The colour of the flesh is orange-yellow, not the rich salmon-colour of a fine common trout in good season. The stomach is very capacious, and on dissection (differing singularly in this respect from the salmon) is almost always found gorged with fish.

We have bestowed a somewhat lengthened notice on the species above described; but we doubt not that the obscurity of the subject will not only plead our excuse, but render the information now given highly acceptable both to the sportsman and the naturalist. It is certain that a more attentive examination of the finny tribes which inhabit our lakes and rivers would bring to light several new species, and more clearly illustrate the history of others which are still involved in darkness.[1]

The gigantic species of the Swiss lakes, one of which,

[1] Mr Lascelles once killed two trouts in Loch Laggan, which weighed 12 pounds each. These were probably of the same species with the great trouts of Loch Awe. In that magnificent chain of English lakes of which Windermere is the chief, and which includes Grassmere and Rydal, we think the species not synonymous with the *salmo ferox* of Jardine. The lake trouts, properly so called, of these beautiful waters, when full-grown, seem to range from three to five pounds, and have in one or two rare instances been taken of the weight of six and even eight pounds. Those of Ullswater, again, which does not belong to what we have denominated the Windermere chain, correspond more nearly in size and other characters with the species found in the lakes of the Scottish Highlands. We would particularly recommend to the attention of sportsmen the great fresh-water river trout, or bull trout as we believe it is sometimes called. This is regarded by some anglers as an aged or overgrown individual of the ordinary kind (*salmo fario*); and by others, especially when found in the autumn, as a lake trout which had left its more usual haunts for the purpose of spawning. The accuracy of the latter opinion is, however, interfered with by the occasional occurrence of this variety in such unambiguous situa-

killed in the lake of Geneva, weighed 67 pounds, seem closely allied to those of Loch Awe, Ullswater, &c. Though equal to salmon, both in size and strength, they differ in their habits from those fish, and do not appear at any time to seek the waters of the ocean. Indeed their existence in the lake of Constance, the available communication of which with the sea is cut off by the falls of Schaffhausen, demonstrates their independence of saline waters. It does not appear, from any information which has reached us on the subject, that these great continental lake-trouts ever rise at the artificial fly.

In Loch Craggie there is a finely formed and beautiful variety of the common trout, varying in its matured condition from one and a half to three pounds in weight. It affords excellent sport to the angler fishing from a boat a few yards off the deeper parts of the shores. They rise freely to small salmon or sea-trout flies, dressed after the model of a gray or green drake.

The rich and varied supply of all kinds of tackle, which may be obtained in the shops of the principal dealers in our larger cities, induces us to abstain from any description of the different hooks employed in minnow and other bait-fishing, as such details are not very intelligible without the aid of numerous engravings. More knowledge will be gained by a few minutes' inspection of the articles themselves in the hands of an intelligent workman, than can be conveyed by the most elaborate treatise on the subject.

Having described the characteristic modes of angling for salmon and trout, the two species which so greatly surpass all the others in the amusement yielded to the angler, we shall now proceed to a briefer consideration of some of the remaining subjects of our sport.

The Char or Case Char. (*Salmo Alpinus.*)
The Torgoch or Red Char. (*Salmo Salvelinus.*)

These fish, which, in a culinary point of view, are deservedly the most highly prized of all the permanently freshwater species, are scarcely attainable by the angler's skill. Of late years they have risen more freely than in former times in the meres of the north of England; but the capture of a char by rod and line is still regarded as an uncommon occurrence. They appear to retire during the warmer months to the deepest of the still waters, as the fishermen engaged in throwing their nets for pike, perch, and trout, over the very grounds where, during the colder season of the year, the char abound, never catch any of these fish in summer. Although a good deal has been written upon the subject, it does not appear that the distinctive history of the two species above named has been as yet made out. Both the case char and the red char are found in Windermere; and the principal distinction in their habits and history consists in this, that the former ascends the rivers, where it spawns about Michaelmas; whereas the latter deposits its ova along the shores of the lake, and not till the end of December or the beginning of the year. In angling for char the same flies may be used as those best adapted for the smaller-sized lake-trouts; and as the latter occur wherever the former is found, the sportsman has the better chance of making amends for the probable disappointment which will attend his pursuit of the one, by a more successful capture of the other.

The Grayling. (*Salmo Thymallus.*)

This fish loves the clear streams of mountainous countries. It is common in Lapland, where its intestine is used as rennet, along with rein-deer milk, in the formation of cheese. It is a bold and sportive fish, but more tender in the mouth than the trout. It rises well to the camlet fly, and to several of the other small-sized trout-flies. We killed it readily in Switzerland with a moorfowl wing and hare-ear body. They may also be taken with the caddis worm and other ground baits. According to the Rev. Mr Low, the grayling is frequent in the streams of the Orkney Islands, though very rare in the rivers of the mainland of Scotland.

The Pike. (*Esox Lucius.*)

This "fell tyrant of the liquid plain" is not regarded as indigenous to the waters of Britain, but is said to have been introduced in the time of Henry VIII. That it was well known in England at an earlier period is however evident, both from the book of St Alban's, printed by Wynken de Worde in 1496, and from the account of the great feast given by George Nevil, archbishop of York, in the year 1466. There is in truth no evidence either of its non-existence in this country at a remote period, or of its importation during comparatively recent times.

The voracity of this fish is almost unexampled, even in a class remarkable for their omnivorous propensities. Goslings, young ducks, and coots, water-rats, kittens, and the young of its own species, besides every kind of fresh-water fish, have been found in the stomach of the pike. It is said to contend with the otter for its prey, and has been known to pull a mule into the water by the nose. This fish is in season from May to February, and is angled for by trolling with a strong-topped rod. The hooks are generally fastened to a bit of brass wire for a few inches from the shaft, to prevent the line from being snapped. Different methods are used in angling for pike. *Trolling*, in the more limited sense of the word, signifies catching fish with the gorge hook, which is composed of two, or what is called a double eel-hook; *live bait-fishing* is practised with the aid of a floated line; and *snap-fishing* consists in the use of large hooks, so baited as to enable the angler to strike the fish the moment he feels it bite, immediately after which he drags it *nolens volens* ashore.

Trolling for pike may be practised during the winter months, when trout fishing has ceased; and the colder season of the year is in fact more convenient for the sport, owing to the decay or diminution of the weeds which usually surround their favourite haunts. With the exception of chub and dace, which bite pretty freely at the bottom all winter, scarcely any other fish can be relied upon for sport during the more inclement portion of the year. To bait a gorge hook, take a baiting needle, and hook the curved end to the loop of the gimp, to which the hook is tied; see Plate XLI. fig. 20; then introduce the point of the needle into a dead bait's mouth, and bring it out at the middle of the fork of the tail, by which means the piece of lead which covers the shank of the hook, and part of the connecting wire, will lie concealed in the interior of the bait: the shank will be in the inside of its mouth, and the barbs on the outside, turning upwards. See Plate LXI. fig. 24. To keep the bait steady on the hook, fasten the tail part just

tions as the Clyde above the falls, the waters of which have no communication with any lake. This species sometimes attains the weight of 8, 10, or even 12 pounds; but it differs from the Loch Awe trout in being generally, if not exclusively, found in rivers. Those of many of the lesser Highland lakes, such as Loch Ard and Loch Chon, ascend the mountain streams in the autumn to spawn, and in the ordinary practice of angling (with the artificial fly) are rarely caught above the weight of three pounds. In the year 1829 we received some very singular trouts from a small loch called Lochdow, near Pitmain, in Inverness-shire. Their heads were short and round, and their upper jaws were truncated like that of a bull-dog. They do not occur in any of the neighbouring lochs, and have not been observed above the weight of half a pound. Trouts of the ordinary shape likewise occur in Lochdow

Angling.

above the fork to the gimp, with a silk or cotton thread; or a neater method is, to pass the needle and thread through the side of the bait, about half an inch above the tail, so as to encircle the gimp in the interior. The baits used vary in weight from one to four ounces, and the hooks must be proportioned to the size of the fish with which they are baited. The barbs of the hook ought not to project much beyond the sides of the mouth, because, as the pike generally seizes his prey crosswise, and turns it before it is pouched or swallowed, if he feels the points of the hook he may cast it out entirely.

In trolling for pike, it is advised to keep as far from the water as possible, and to commence casting close by the near shore, with the wind blowing from behind. When the water is clear and the weather bright, some prefer to fish against the wind. "After trying closely," says Mr Salter, "make your next throw further in the water, and draw and sink the baited hook, drawing it straight upwards near to the surface of the water, and also to right and left, searching carefully every foot of water; and draw your bait with the stream, because you must know that jack and pike lay in wait for food with their heads and eyes pointing up the stream, to catch what may be coming down; therefore experienced trollers fish a river or stream down, or obliquely across; but the inconsiderate as frequently troll against the stream, which is improper, because they then draw their baited hook behind either jack or pike when they are stationary, instead of bringing it before his eyes and mouth to tempt him. *Note.*—Be particularly careful, in drawing up or taking the baited hook out of the water, not to do it too hastily, because you will find by experience that the jack and pike strike or seize your bait more frequently when you are drawing it upwards than when it is sinking. And also further observe, that when drawing your bait upwards, if you occasionally shake the rod, it will cause the bait to spin and twist about, which is very likely to attract either jack or pike."[1]

These fish are partial to the bends of rivers and the bays of lakes, where the water is shallow, and abounding in weeds, reeds, water lilies, &c. In fishing with the gorge hook, and the angler feels a run, he ought not to strike for several minutes after the fish has become stationary, lest he pull the bait away before it is fairly pouched. If a pike makes a very short run, then remains stationary for about a minute, and again makes one or two short runs, he is probably merely retiring to some quiet haunt before he swallows the bait; but if, after remaining still for three or four minutes, he begins to shake the line and move about, the inference is that he has pouched the bait, and feels some annoyance from the hook within, then such part of the line as has been slackened may be wound up, and the fish struck. It is an unsafe practice to lay down the rod during the interval between a run and the supposed pouching of the bait, because it not unfrequently happens that a heavy fish, when he first feels the hooks in his interior, will make a sudden and most violent rush up the river or along the lake, and the line is either instantly broken, or is carried, together with both the rod and reel, for ever beyond the angler's reach. "When the pike cometh," says Colonel Venables, "you may see the water move, at least you may feel him; then slack your line and give him length enough to run away to his hould, whither he will go directly, and there pouch it, ever beginning (as you may observe) with the head, swallowing that first. Thus let him lye untill you see the line move in the water, and then you may certainly conclude he hath pouched your bait, and rangeth about for more; then with your trowl wind up your line till you think you have it almost streight, then with a smart jerk hook him, and make your pleasure to your content."[2]

The fresher and cleaner the bait is kept, whether for trolling, live-bait, or snap-fishing, the greater is the chance of success.

As pike, notwithstanding their usual voracity, are sometimes, as the anglers phrase it, more on the play than the feed, they will occasionally seize the bait across the body, and, instead of swallowing it, blow it from them repeatedly and then take no further notice of it. The skilful and wily angler must instantly convert his gorge into a snap, and strike him in the lips or jaws when he next attempts such dangerous amusement. The dead snap may be made either with two or four hooks. (See Plate XLI. fig. 21.) Take about twelve inches of stout gimp, make a loop at one end, at the other tie a hook (size No. 2), and about an inch farther up the gimp tie another hook of the same dimensions; then pass the loop of the gimp into the gill of a dead bait-fish, and out at its mouth, and draw the gimp till the hook at the bottom comes just behind the back fin of the bait, and the point and barb are made to pierce slightly through its skin, which keeps the whole steady: now pass the ring of a drop-bead lead over the loop of the gimp, fix the lead inside the bait's mouth, and sew the mouth up. (See Plate XLI. fig. 22.) This will suffice for the snap with a couple of hooks. If the four-hooked snap is desired (and it is very killing), take a piece of stout gimp about four inches long, and making a loop at one end, tie a couple of hooks of the same size, and in the same manner as those before described. After the first two and the lead are in their places, and previous to the sewing up of the mouth, pass the loop of the shorter gimp through the opposite gill, and out at the mouth of the bait; then draw up the hooks till they occupy a position corresponding to those of the other side: next pass the loop of the longer piece of gimp through that of the shorter, and pull all straight: finally, tie the two pieces of gimp together close to the fish's mouth, and sew the latter up.

Some anglers prefer fishing for pike with a floated line and a live bait. When a single hook is used for this purpose, it is baited in one or other of the two following ways: Either pass the point and barb of the hook through the lips of the bait, towards the side of the mouth, or through beneath the base of the anterior portion of the dorsal fin. (See Plate XLI. fig. 25.) When a double hook is used take a baiting needle, hook its curved end into the loop of the gimp, and pass its point beneath the skin of the bait from behind the gills upwards in a sloping direction, bringing it out behind the extremity of the dorsal fin; then draw the gimp till the bend of the hooks are brought to the place where the needle entered, and attach the loop to the trolling line. (See Plate XLI. fig. 23.) Unless a kind of snap-fishing is intended, the hooks for the above purpose should be of such a size as that neither the points nor the barbs project beyond either the shoulder or the belly of the bait.

Snap-fishing is certainly a less scientific method of angling for pike than that with the gorge or live bait; for when the hooks are baited the angler casts in search, draws, raises, and sinks his bait, until he feels a bite. He then strikes with violence, and drags or throws his victim on shore; for there is little fear of his tackle giving way,

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[1] *The Troller's Guide*, by T. F. Salter, Lond. 1820. In the work above quoted will be found a full account of the necessary implements, and the most approved practice, in this department of the art.

[2] *The Experienced Angler*, p. 36. Third edit. Lond. 1668.

as that used in snap-fishing is of the largest and strongest kind. "This hurried and unsportsman-like way of taking fish," it is observed in the *Troller's Guide*, "can only please those who value the game more than the sport afforded by killing a jack or pike with tackle which gives the fish a chance of escaping, and excites the angler's skill and patience, mixed with a certain pleasing anxiety, and the reward of his hopes. Neither has the snap-fisher so good a chance of success, unless he angles in a pond or piece of water where the jack or pike are very numerous or half starved, and will hazard their lives for almost any thing that comes in their way. But in rivers where they are well fed, worth killing, and rather scarce, the coarse snap-tackle, large hooks, &c. generally alarm them. On the whole, I think it is two to one against the snap in most rivers; and if there are many weeds in the water, the large hooks of the snap, by standing rank, are continually getting foul, damaging the bait, and causing much trouble and loss of time."

Pike sometimes rise at an artificial fly, especially in dark, windy days. The fly ought to be dressed upon a double hook, and composed of very gaudy materials. The head is formed of a little fur, some gold twist, and (if the angler's taste inclines that way, for it is probably a matter of indifference to the fish) two small black or blue beads for eyes. The body is framed rough, full, and round, the wings not parted, but made to stand upright on the back, with some small feathers continued down the back to the end of the tail, so that when finished they may exceed the length of the hook. The whole should be about the bulk of a wren. The largest pike ever killed in Britain was taken with a peacock-feather fly in Loch Ken, near New Galloway. It weighed 72 pounds.[1]

During clear and calm weather in summer and autumn, pike take most freely about three in the afternoon: in winter they may be angled for with equal chances of success during the whole day: early in the morning and late in the evening are the periods best adapted for the spring.

The Carp. (*Cyprinus Carpio.*)

This fish, like the preceding, is asserted to have been introduced into England by Leonard Mascal, a gentleman of Sussex, early in the 16th century; and in good company, if there is truth in the old distich,

> Turkies, carps, hops, pickerell, and beer,
> Came into England all in one year.

The carp is, however, mentioned as a *dayntous fysshe*, though scarce, by Juliana Berners, in the year 1496. It attains to a prodigious size in the waters of the south of Europe, and in the Lake of Como is said sometimes to weigh 200 pounds. It breeds more freely in ponds than in rivers, although those of the latter are more esteemed. Angling for carp requires, according to Walton, "a very large measure of patience." The haunts of this fish in the winter months are the broadest and least disturbed parts of rivers, where the bottom is soft and muddy; but in summer it usually lies in deep holes, near some *scour*, under roots of trees, and beneath hollow banks, or in the neighbourhood of beds of aquatic weeds. In ponds they thrive best in a rich marl or clayey soil, where they have the benefit of shade from an overhanging grove of trees.

Small carp bite eagerly, but the larger and more experienced fish are deceived with difficulty. The rod should be of good length, the line strong, furnished with a quill float, and ending in a few lengths of the best silk-worm gut. The hook is proportioned to the size of the bait, and a single shot is fixed about 12 inches above it. "Three rods," says Daniel, "may be employed; one with the bait at mid-water, another a foot or less from the bottom, and the third to lie upon it when the line and lead are not discovered, as in the two former; the places intended to be fished in should, the night before, be ground-baited with grains, blood, and broken worms, incorporated together with clay, the hook baits should be red worms taken out of tan, flag or marsh-worms, green peas so boiled as to soften, but not to break the skin, and throwing some in now and then. When this bait is used (which should be with one on the hook to swim a foot from the ground), in case of a bite, strike immediately; a large carp, upon taking the bait, directly steers for the opposite side of the river or pond."[2] During hot weather, when these fish are about to spawn, and whilst lying among the weeds near the surface, they may be angled for with a fine line, without either sink or float. The hook may be baited with a red worm, a pair of gentles, a caterpillar, or a cad bait, and thrown lightly as in fly-fishing, and then drawn towards the angler. If it can be made to fall first upon the leaf of some water plant, and then dropped upon the surface, the chance of success will be increased. The best months are May, June, and July, and the most advisable times of the day are from sunrise to eight in the morning, and from sunset during the continuance of twilight, and onwards through the night. It is the opinion of many, though we cannot trace the origin of the idea, no doubt an erroneous one, that the 10th of April is a fatal day for carp.

The Bream. (*Cyprinus Brama.*)

This fish breeds both in deep, slow-running rivers, and in ponds. It prefers the latter. The most enticing bait is a well-conditioned earthworm, although the angler also uses paste made of bread and honey, wasp grubs, grass-hoppers, &c. Boiled wheat serves well for ground-baiting the spot on the preceding nights, and some fasten a number of worms to a piece of turf, and sink it to the bottom. When the ground has been thus prepared, and the tackle put in order, the angler should commence his labours by three or four in the morning. Let him approach the place with caution, so as not to be perceived by the fish, and cast his hook neatly baited with a live and moving worm, in such manner that the lead may lie about the centre of the prepared ground. The bream is a strong fish, and runs smartly when first struck; but after a few turns he falls over on his side, and allows the angler to land him without much trouble. He is by no means so lively as the carp. The best hours for bream are from four till eight in the morning, and from four in the afternoon till eight in the evening. In the river Trent, near Newark, there are two kinds of bream. The common species is that called the carp bream, from its yellow colour; and it sometimes attains the weight of eight pounds. The other species or variety, regarded by Mr Revett Shepherd as a nondescript, never exceeds a pound in weight. It is of a silvery hue, and is known by the name of white bream.[3] The bream, though rare in Scotland, occurs in Loch Maben.

The Tench. (*Cyprinus Tinca.*)

This species is a lover of still waters, and his haunts in rivers are among weeds, or pools well screened by bushes. Tench are found spawning from June till September, and they are in the best condition from the latter month till the end of May. The tackle should be strong, with a swan or goose-quill float for ponds, and a piece of cork for rivers. The hook (in size from No. 4 to 6) should

[1] Daniel's *Rural Sports*, vol. ii. p. 275.

[2] *Ibid.* p. 257.

[3] *Linn. Trans.* vol. xiv. p. 587.

be whipt to sound silk-worm gut, with two or three shot fixed to it at the distance of a foot. The bait should float about a couple of feet from the surface, and should be drawn occasionally gently upwards, and allowed slowly to sink again. Small marsh worms, middle-sized lobs, or the red species found in rotten tan, are to be recommended. " He will bite," says Walton, " at a paste made of brown bread and honey, or at a marsh-worm, or a lob-worm: he inclines very much to any paste with which tan is mixed, and he will bite also at a smaller worm with his head nipped off, and a sod-worm put on the hook before that worm; and I doubt not but that he will also in the three hot months, for in the nine colder he stirs not much, bite at a flag-worm, or at a green gentle: but can positively say no more of the tench, he being a fish that I have not often angled for; but I wish my honest scholar may, and be ever fortunate when he fishes."

The Barbel. (*Cyprinus Barbus.*)

In a culinary point of view this is one of the worst of the fresh-water fishes. It is gregarious, and roots among the soft banks with its nose, like a sow. The angling season commences in May, and continues till September. The most approved hours are from daylight till ten in the morning, and from four in the afternoon till about sunset. The line should be strong and rather heavily leaded, so that the bait may float about half an inch from the ground. Considerable caution is required in playing this fish, as he is apt to run off when struck, with great violence, towards some stronghold, and in so doing sometimes breaks both rod and line. He is rather nice in his baits, which must be kept clean and sweet, and untainted by musty moss. " One caution," says Mr Daniel, " in angling for barbel, will bear repetition: never throw in the bait farther than enabled by a gentle cast of the rod, letting the plumb fall into the water with the least possible noise. It is an error to think that large fish are in the middle of the river: experience teaches the fallacy of this opinion: they naturally seek their food near the banks, and agitating the waters by an injudicious management of the plumb will certainly drive them away. It is incredible the quantities of barbel sometimes caught by this method. Persons of great veracity have asserted that upwards of one hundredweight have been taken in one morning."

The Chub. (*Cyprinus Cephalus.*)

The rivers of England are stored with a much finer variety of fresh-water fish than those of Scotland. The chub occurs in the Annan. It is however a fish but lightly esteemed, either for sport or the table. He is a dull fish on the hook, bites eagerly, and is soon tired. Caution is requisite on the part of the angler, as the chub is naturally fearful, and sinks towards the bottom of the stream on the slightest alarm. The baits used are maggots, beetles, grasshoppers, salmon-roe, &c. Black and dun flies gaudily dressed, and ribbed with gold or silver twist, are well adapted to take them in streams. They likewise rise at the red-spinner. But perhaps the best way to secure this fish is by *dibbing* with a grasshopper. As chub are often seen in some favourite haunt lying near the surface of the pool, the angler, concealing himself as much as possible, ought to move his rod cautiously over the spot, and drop his bait gently upon the water, a few inches in advance of the fish's head. The landing net is particularly necessary in angling for chub, as the best spots are generally encumbered by trees or bushes, which prevent the fish from being drawn to hand, or pulled ashore.

The Dace. (*Cyprinus Leuciscus.*)

This fish is of gregarious habits, and haunts the deeper waters near the piles of bridges, shady pools, and beneath the masses of collected foam caused by eddies. In the warmer months of the year they also congregate in the shallows. They rise at a variety of flies, and are likewise angled for with red worms, brandlings, &c. Above Richmond, as soon as the weeds begin to rot, a grasshopper used as an artificial fly is found very successful in hot weather among the shallows. This mode can only be practised in a boat, with a heavy stone to serve as an anchor, fastened to a few yards of rope. The boat drifts gently down the stream, and the stone is dropped whenever the angler considers himself in the neighbourhood of a likely place. Standing in the stern, he first throws directly down the stream, and then to the right and left; and after trying for about a quarter of an hour in one spot, he again weighs anchor, and proceeds to another station.

The Roach. (*Cyprinus Rutilus.*)

The carp has been named the " water-fox" on account of his subtlety, and the roach the " water-sheep," by reason of his silliness. This fish makes good soup, though very bony, and otherwise not much esteemed. The season for roach fishing in the Thames, where it attains to a larger size than elsewhere, commences about the end of August. " Next let me tell you," says Walton, " you shall fish for this roach in winter with paste or gentles, in April with worms or caddis, in the very hot months with little white snails, or with flies under water; for he seldom takes them at the top, though the dace will. In many of the hot months roaches may be also caught thus:—Take a May-fly or ant-fly; sink him with a little lead to the bottom, near the piles or posts of a bridge, or near to any posts of a wear—I mean any deep place where roaches lie quietly—and then pull your fly up very leisurely, and usually a roach will follow your bait to the very top of the water, and gaze on it there, and run at it, and take it, lest the fly should fly away from him."[1] Vast shoals of this species ascend the streams in the parish of Killearn, from Loch Lomond, and are caught by nets in thousands. Their emigration from the loch, however, continues only for the space of three or four days towards the end of May.[2]

The Bleak. (*Cyprinus Alburnus.*)

This small and active fish may be angled for with what is called a *pater noster* line, which consists of half a dozen fine hooks fastened about 6 or 8 inches from each other. These may be baited with gentles, or more variously, to increase the temptation, with a gentle, a small red worm, a fly, &c. and thus several fish may be hooked at the same time. In angling for bleak the tackle must be very fine. In fresh streams they rise well at the black gnat, or any other small sad-coloured fly.

The Gudgeon. (*Cyprinus Gobio.*)

Gudgeons are angled for near the ground with a small red worm. They frequent the shallows during the hot months, and retire before winter to the stiller and deeper waters. As an article of food they are highly esteemed.

The Minnow. (*Cyprinus Phoxinus.*)

This is the fish by means of which most youthful anglers commence their experience of the art. " He is a sharp biter," says Walton, " at a small worm, and in hot

[1] *Complete Angler*, p. 218.

[2] *Statistical Account of Scotland*, vol. xvi. p. 100.

weather makes excellent sport for young anglers, or boys, or women that love that recreation; and in the spring they make of them excellent minnow-tansies; for being washed well in salt, and their heads and tails cut off, and their guts taken out, and not washed after, they prove excellent for that use; that is, being fried with yolks of eggs, the flower of cowslips and of primroses, and a little tansie. Thus used, they make a dainty dish of meat."

The Loach. (*Cobitis Barbatula.*)

The loach is entirely a ground fish, living in clear and gravelly streams. It is an excellent bait for eels, and is also a nutritious food for man, though of a slimy and somewhat forbidding aspect.

The Eel. (*Anguilla Vulgaris.*)

This well-known and snake-like species has its favourite haunts in the muddy bottom of the bays of lakes, among weeds, under large stones, and in the clefts of the banks of rivers. The habits of the eel are nocturnal, and the largest and finest are usually caught with night-lines. They are troublesome fish, from their great tenacity of life, and the tortuous motions by which, in their endeavours to disengage themselves, they entangle or destroy the angler's tackle. They afford little amusement to those accustomed to the more elegant branches of the art.

The isle of Ely, according to some authorities, was so called in consequence of its being the place from whence the kings of England were anciently supplied with eels. Indeed Cambridgeshire is still famous for this fish.[1]

The Perch. (*Perca Fluviatilis.*)

This gregarious fish is angled for with a worm or minnow. It is a bold biter during the warm months of the year, though very abstemious in the winter season. When a shoal is met with, great sport is frequently obtained. A small cork float is used, and the bait is hung at various depths, according to circumstances, a knowledge of which can only be obtained by practice. In angling near the bottom, the bait should be frequently raised nearly to the surface, and then allowed gently to sink again. When the weather is cool and cloudy, with a ruffling breeze from the south, perch will bite during the whole day. The best hours towards the end of spring are from seven to eleven in the morning, and from two to six in the afternoon. In warm and bright summer weather, excellent times are from sunrise till six or seven in the morning, and from six in the evening till sunset.

The first printed work on angling in the English language is by Dame Juliana Barnes or Berners (*The Treatyse of Fysshinge with an Angle*), and forms part of the *Book of St Alban's, emprented at Westmestre by Wynken de Worde*, in 1496. Of this book there are various old editions, and it has, we believe, been twice reprinted in modern times. It is less useful to the angler than curious in the eyes of the bibliographer. Hawking, Hunting, Fouling, and Fishing, with the true measures of Blowing, &c. now newly collected by W. G. Faukener. 4to, Lond. 1596. A Book of Fishing with Hooke and Line, and of all other Instruments thereunto belonginge, made by L. M. 4to, Lond. 1590. This work contains remarks on the preservation of fish in pools, and some improvements on the directions of the "religious sportswoman" Juliana Barnes. L. M. signifies Leonard Mascall. A Neu Book of good Husbandry, very pleasaunt, and of great profite, both for gentlemen and yeomen; conteining the Order and Maner of Making of Fish-pondes, with the Breeding, Preseruing, and Multiplyinge of the Carpe, Tench, Pike, and Troute, and diverse kindes of other Fresh Fish. Written in Latine by Janus Dubrauius, and translated into English at the speciale request of George Churchey, Fellow of Lion's Inne, the 9th Februarie 1599. 4to, Lond. 1599. Certain Experiments concerning Fish and Fruit, practised by John Taverner, Gentleman, and by him published for the benefit of others. 4to, Lond. 1600. The Secrets of Angling; teaching the Choicest Tooles, Baytes, and Seasons for the taking of any Fish in Pond or River: practised and familiarly opened in Three Bookes. By J. D., Esquire. 8vo, Lond. 1613. The author of this work is named in the third edition of Walton's Angler as one Jo. Davors; but, from an entry in the books of Stationers Hall, as given in the second volume of "British Bibliography," p. 355, he is mentioned as John Dennys, Esquire. Large extracts from this work are given by Sir Egerton Bridges, in the last volume of his *Censura Literaria.* The poetry, of which several passages are quoted by Walton, is remarkable for its beauty. As the volume is rare, we shall here present the reader with a few stanzas.

> You nymphs that in the springs and waters sweet
> Your dwelling have, of every hill and dale,
> And oft amid the meadows green do meet
> To sport and play, and hear the nightingale,
> And in the rivers fresh do wash your feet,
> While Progne's sister tells her wofull tale;
> Such ayd and power unto my verses lend
> As may suffice this little work to end.
>
> And thou, sweet Boyd, that with thy wat'ry sway
> Dost wash the cliffes of Deignton and of Week,
> And through their rocks with crooked winding way
> Thy mother Avon runnest soft to seek;
> In whose fair streams the speckled trout doth play,
> The roach, the dace, the gudgin, and the bleike;
> Teach me the skill, with slender line and hook,
> To take each fish of river, pond, and brook.

In comparing the amusement of angling with the excitement to be derived from gaming and other pleasures, he adds—

> O let me rather on the pleasant brinke
> Of Tyne and Trent possess some dwelling place,
> Where I may see my quill and corke down sinke,
> With eager bite of barbel, bleike, or dace;
> And on the world and his Creatour thinke,
> While they proud Thais painted sheet embrace;
> And with the fume of strong tobacco smoke
> And quaffing round are ready for to choke.
>
> Let them that list these pastimes then pursue,
> And on their pleasing fancies feed their fill;
> So I the fields and meadows green may view,
> And by the rivers fresh may walke at wille,
> Among the dazies and the violets blue,
> Red hyacinth and yellow daffodil,
> Purple narcissus like the morning rayes,
> Pale ganderglas, and azore culverkayes.
>
> I count it better pleasure to behold
> The goodly compasse of the lofty skie;
> And in the midst thereof, like burning gold,
> The flaming chariot of the world's great eye;

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[1] "Here I hope I shall not tresspass upon gravity, in mentioning a passage observed by the reverend professor of Oxford, Doctor Prideaux, referring the reader to him for the author's attesting the same. When the priests in this part of the country would still retain their wives, in despight of whatever the pope or monks would doe to the contrary, their wives and children were miraculously turned all into eels (surely the great into *Congers*, the less into Greggs), whence it had the name of Eely. I understand him, a Lie of Eels." (Fuller's *Worthies. Cambridgeshire.*)

The wat'ry clouds that in the ayre uprol'd
With sundry kinds of painted colours flie;
And faire Aurora lifting up her head,
All blushing rise from old Tithonus bed.

The hills and mountains raised from the plains,
The plains extended levell with the ground,
The ground divided into sundry vains,
The vains enclos'd with running rivers round,
The rivers making way thro' nature's chains,
With headlong course into the sea profound;
The surging sea beneath the vallies low,
The vallies sweet, and lakes that lovely flow.

Then follow the two stanzas quoted at the beginning of this article. Our next work on angling is The Pleasures of Princes, or Good Men's Recreations; containing a Discourse of the General Art of Fishing with the Angle, or otherwise, and of all the hidden secrets belonging thereunto; together with the Choyce, Ordering, Breeding, and Dyetting of the Fighting Cocke; being a worke never in that nature handled by any former author. Lond. 1614, 4to. This work forms part of the second book of the English Husbandman, by G. M. (Gervais Markham.) A Briefe Treatise of Fishing; with the Art of Angling. Lond. 1614, 4to. This work is little else than a reprint from a portion of the Book of St Alban's, and forms part of the Jewell for Gentrie, by T. S. Cheap and Good Husbandry, by Gervais Markham. 4to, Lond. 1616. This work contains a chapter on Fish and Fish-Ponds. Country Contentments; or the Husbandman's Recreations, by J. M. In the fifth and sixth editions of this volume (4to, Lond. 1633 and 1639), will be found, the Whole Art of Angling, as it was written in a small treatise in rime, and now, for the better understanding of the reader, put into prose, and adorned and enlarged. This work is a prose version, with additions, of Davors' Secrets of Angling. The Country Gentleman's Companion, 2 vols. 12mo, Lond. 1753, is a reprint, without acknowledgement, of Markham's work. The Art of Angling; wherein are discovered many rare secrets very necessary to be known by all that delight in that recreation, written by Thomas Barker, an antient practitioner in the said art. 12mo, Lond. 1651. In an epistle to the reader, prefixed to the first edition, and in the dedication of the two last to Edward Lord Montague, Barker speaks of himself as having practised angling for more than half a century. He also says he was born and educated at Bracemeall, in the liberty of Salop, being a freeman and burgesse of the same city; adding, "if any noble or gentle angler, of whatever degree soever he be, have a mind to discourse of any of these wayes and experiments, I live in Henry the 7th's Gifts, the next doore to the Gatehouse, in Westm. My name is Barker, where I shall be ready, as long as please God, to satisfye them, and maintain my art during life, which is not like to be long." See British Bibliography, by Sir Eg. Bridges and Joseph Haselwood, vol. ii. p. 356. The Compleat Angler, or the Contemplative Man's Recreation; being a discourse of Fish and Fishing, not unworthy the perusal of most anglers. 12mo, Lond. 1653. This is the first edition of Izaak Walton's celebrated work. It went through five editions during the author's lifetime; and in the course of its republication was enlarged and improved. The fifth edition forms the first part of the Universal Angler, by Walton, Cotton, and Venables, 12mo, Lond. 1676; and is accompanied by a *second part* (written by Cotton), which treats more fully of fly-fishing. The sixth and seventh editions were published in 1750 and 1759, by Moses Browne, author of the Piscatory Eclogues and other works. The eighth edition was published by Sir John Hawkins in 1760, and has been succeeded by many others since that period, of which the most recent and most beautifully adorned is that by John Major, with an introductory essay and illustrative notes. 8vo, Lond. 1823. The third edition of the Compleat Gentleman, by Henry Peacham, 4to, Lond. 1661, contains a chapter concerning Fishing. The Experienced Angler, or Angling Improved; being a general discourse of Angling. 8vo, Lond. 1662. This work, of which there are several editions, is by Colonel Robert Venables. Its fourth edition forms the third part of the Universal Angler. Angling Improved to Spiritual Uses, forms part of an octavo volume entitled Occasional Reflections upon several Subjects, by the Hon. Robert Boyle. 8vo, Lond. 1665. In a volume called The Epitome of the Art of Husbandry, by J. B. Gent. 12mo, Lond. 1669, are brief experimental directions for the right use of the angle. The author's name was Blagrave. The Angler's Delight; containing the whole Art of Neat and Clean Angling; wherein is taught the readiest way to take all sorts of Fish, from the Pike to the Minnow, together with their proper baits, haunts, and time of fishing for them, whether in mere, pond, or river. As also the method of fishing in Hackney River, and the names of all the best stands there; with the manner of making all sorts of good tackle fit for any water whatsoever. The like never before in print. By William Gilbert, Gent. 12mo, Lond. 1676. The Compleat Troller, or the Art of Trolling, by Robert Nobbes. 8vo, Lond. 1682. There are several editions of this work, of which the third and fourth are appended to the Angler's Pocket-Book. Gentleman's Recreations; treating of the Art of Horsemanship, Hunting, Fowling, Fishing, and Agriculture. Fol. Lond. 1686. The Gentleman's Recreation, in four parts, viz. Hunting, Hawking, Fowling, Fishing. 8vo, Lond. 1674. (By Nicholas Cox.) The Angler's Vade Mecum, or a compendious yet full Discourse of Angling. By T. Cheetham. 8vo, Lond. 1681. Northern Memoirs, calculated for the meridian of Scotland; wherein most or all of the Cities, Citadels, Seaports, Castles, Forts, Fortresses, Rivers, and Rivulets, are compendiously described; to which is added, the Contemplative and Practical Angler, by way of diversion; with a Narrative of that dextrous and mysterious Art experimented in England, and perfected in more remote and solitary parts of Scotland; by way of Dialogue: writ in the year 1658, but not till now made publick. By Richard Franck, Philanthropus. 8vo, Lond. 1694. Of this curious volume a reprint was published of late years. The Gentleman Fisher; or the Whole Art of Angling. 8vo, Lond., second edition, 1727. The True Art of Angling, by J. S. 24to, Lond. 1696. The Compleat Fisher, or the True Art of Angling, by J. S., third edition, 1704. The preceding work, revised and corrected by W. Wright and other experienced anglers, was republished in 1740. The Compleat Fisherman; being a large and particular account of all the several ways of Fishing now practised in Europe; by James Saunders, Esq. of Newton-Awbery, upon Trent. 12mo, Lond. 1724. The Genteel Recreation, or the Pleasure of Angling; a Poem: with a dialogue between Piscator and Corydon. By John Whitney, a lover of the Angle. 8vo, Lond. 1700. The School of Recreation, or a Guide to the most ingenious Exercises; by R. H. 8vo, Lond. 1701. The Secrets of Angling, by C. G. 12mo, Lond. 1705. The Angler's Sure Guide, or Angling Improved and Methodically Digested, by R. H. Esq. 8vo, Lond. 1706. The Innocent Epicure, or the Art of Angling; a Poem. 8vo, Lond. 1697. The whole Art of Fishing, being a Collection and Improvement of all that has been written on this subject; with many new experiments. 12mo, Lond. 1714. The second edition of this work is entitled The Gentleman Fisher, or the whole Art of Angling. 8vo, Lond. 1727. A Discourse of Fish and Fish-Ponds, by a Person of Honour. 8vo. London.

The author of this work was the Hon. Roger North. A subsequent edition (of which there were more than one) bears the date of 1713. It was also published as an appendage to the Gentleman Farmer. 8vo, Lond. 1726. The Country Gentleman's Vade Mecum, by G. Jacob, Gent. 8vo, Lond. 1717; and the Compleat Sportsman, by the same author (1718), of which the 3d part relates to Fish and Fishing. England's Interest, or the Gentleman and Farmer's Friend, by Sir John Moore. 8vo, Lond. 1721. The Gentleman Angler, Lond. 1726. Piscatory Eclogues (by Moses Browne). 8vo, Lond. 1729. Of this work there are several editions. Sportsman's Dictionary, or the Gentleman's Companion in all Rural Recreations. 2 vols. 8vo, 1735. The British Angler, or a Pocket Companion for Gentlemen Fishers, by John Williamson, Gent. 8vo, Lond. 1740. The Art of Angling, Rock and Sea Fishing, with a Natural History of River, Pond, and Sea Fish, by R. Brookes. 8vo, Lond. 1740. Of this treatise there have been various reprints, at different periods, up to the year 1807. Angling, a Poem. 12mo, Lond. 1741, 2d edit. The Art of Angling improved in all its Parts, especially Fly-fishing, by Richard Bowlker. 12mo, Worcester. Published some time preceding the year 1759. There is a recent edition (1806) by Charles Bowlker, Ludlow. The Angler's Magazine, or Necessary and Delightful Store House; wherein every thing proper to be known relating to his art is digested in such a method as to assist his knowledge and practice upon bare inspection; being the completest manual ever published upon the subject, largely treating of all things relating to Fish and Fishing, and whereby the angler may acquire his experience without the help of a master. By a Lover of that innocent and healthful diversion. 12mo, Lond. 1754. The Angler's Eight Dialogues, in Verse. 8vo, Lond. 1758. The Art of Angling, eight Dialogues, in Verse. 8vo. The Universal Angler, or that art Improved in all its Parts, especially in Fly-fishing. 8vo, Lond. 1766. The Complete Sportsman, or Country Gentleman's Recreation, by Thomas Fairfax. 8vo, London. The Complete Fisherman, or Universal Angler. 8vo, Lond. (2d edit.) Lond. 1778. The Angler's Complete Assistant, being an Epitome of the whole Art of Angling. 4th edit. 4to, London. The True Art of Angling. 12mo, Lond. 1770. Translation of a Letter from the Hanover Magazine, No. 23, March 21, 1763; giving an account of a method to breed fish to advantage. 8vo, Lond. 1778. The Angler's Museum, or the whole Art of Float and Fly Fishing, by Thomas Shirley. 12mo, Lond. 1784. The Fisherman, or Art of Angling made Easy, by Guiniad Charfey, Esq. 8vo, London. The North Country Angler, or the Art of Angling as practised in the Northern Counties of England. 8vo, Lond. 1786. A Concise Treatise on the Art of Angling, by Thomas Best, Gent. 8vo, Lond. 1787. Of this work there have been published many editions, of which the 9th is dated 1810. An Essay on the Right of Angling in the River Thames, and in all the other public Navigable Rivers. 8vo, Reading. A Letter to a Proprietor of a Fishery in the River Thames; in which an attempt is made to show in whom the right of Fishing in public streams now resides. 2d edit. 8vo, Reading, 1787. The Natural History of Fishes and Serpents, by R. Brookes; to which is added, an Appendix, containing the whole Art of Float and Fly Fishing. 8vo, Lond. 1790. The Young Angler's Pocket Companion, by Ralph Cole, Gent. 12mo, Lond. 1795. The Modern Angler, being a practical Treatise on the Art of Fishing, &c., in a series of Letters to a Friend; by Robert Salter, Esq. 12mo, London. Angling in all its branches reduced to a complete Science, in three parts, by Samuel Taylor, Gent. 8vo, London, 1800. Practical Observations on Angling in the River Trent. 8vo, Newark, 1801. Every Man his own Fisherman, by Thomas Smith. 24to, London. The Driffield Angler, in two parts, by Alexander Mackintosh of Great Driffield, Yorkshire. 8vo, Gainsborough. The Angler's Pocket Book; to which is prefixed, Nobbes' celebrated Treatise on the Art of Trolling. 8vo, Norw. The New and Complete Angler, or Universal Fisherman, by Richard Pollard, Esq. of Clapton, Middlesex. 8vo, Lond. 1802. Rural Sports, by W. B. Daniel. 4to, Lond. 1802. Part of vol. ii. relates to fly-fishing, and the other kinds of angling. The Kentish Angler, or the Young Fisherman's Instructor; showing the nature and properties of Fish which are angled for in Kent. 12mo, Canterb. 1804. The Complete Angler's Vade Mecum, being a perfect Code of Instruction on the above pleasing Science, &c., by Captain T. Williamson. 8vo, London, 1808. The Angler's Manual, or concise Lessons of Experience, which the proficient in the delightful recreation of Angling will not despise, and the Learners will find the advantage of practising; containing useful Instructions on every approved method of Angling, and particularly on the management of the Hand and Rod in each method. 4to, Liverpool, 1808. The Fisher's Boy, a Poem, by W. H. Ireland. 8vo, 1808. The Angler's Manual, or concise Lessons of Experience, &c. 8vo, 1809. Practical Observations on Angling in the River Trent. 12mo, 1812. Daniel's Rural Sports. Royal 8vo, 1812. Howitt's Foreign Field Sports, Fisheries, &c. 4to, 1814. The Secrets of Angling, by J. D. (Davors); augmented by W. Lawson. 8vo, 1814. The Angler's Guide, by T. F. Salter. 8vo, 1815. Art of Angling, by Charles Bowlker. 12mo, 1815. The Fly-Fisher's Guide, by G. C. Bainbridge. 8vo, 1816. W. H. Scot's British Field Sports. Royal 8vo, 1818. The Angler's Vade Mecum, by W. Carroll. 12mo, 1818. Sportsman's Repository, by J. Scott, 1820. The Troller's Guide, a new and complete Practical Treatise on the Art of Trolling for Jack and Pike; to which is added, the Best Method of Baiting and Laying Lines for large Eels. By T. F. Salter, author of the Angler's Guide. Small 8vo, Lond. 1820. Instructions to Young Sportsmen, by Lieutenant-Colonel Hawker. Royal 8vo, 1824. Salmonia, or Days of Fly-Fishing. By an Angler (the late Sir Humphry Davy). 12mo, Lond. 1828. There is a recent edition (1852), with Notes, by John Davy, M.D., F.R.S., &c. Angler's Souvenir, by P. Fisher. 12mo. The Art of Angling, by Thomas Barker, 12mo. Angling Excursions, by Geoffry Green-drake. 12mo. Letters on Angling, Shooting, &c., by Robert Lascelles. 8vo. Practical Fly-Fishing, with remarks on Fly Rods. 12mo. The British Angler's Manual, by T. C. Hofland. 8vo, Lond. 1830; (revised by Jesse. 8vo, Lond. 1848.) Alphabet of Scientific Angling, by James Rennie. 12mo, Lond. 1833. Trout and Salmon Fishing in Wales, by G. A. Hansard. 12mo, Lond. 1834. Scenes and Recollections of Fly-Fishing, by Stephen Oliver. 12mo, Lond. 1834. Angler in Wales, by Captain Medwin. 2 vols. 8vo, Lond. 1834. Angler in Ireland, by Belton. 2 vols. post 8vo, Lond. 1834. The Art of Angling as practised in Scotland, by Thomas Tod Stoddart. 12mo, 1835. Piscatorial Reminiscences and Gleanings, by an old Angler. 12mo, Lond. 1835. The Angler's Manual, or Fly-Fisher's Oracle, by John Turton. 12mo, Lond. 1836. Angler's Rambles, by Edward Jesse. Post 8vo, Lond. 1836. Notes on Nets, &c., by Charles Bathurst. 12mo, Lond. 1837. Treatise on the Art of Fly-Fishing, Trolling, &c., by William Shipley. 12mo, Lond. 1838. Maxims and Hints on Angling, by Richard Penn. 12mo, Lond. 1839. Northern Angler: Fly-Fisher's Companion, by John Kirkbride. 12mo, Lond. 1840. Vade Mecum of Fly-Fishing for Trout, by G. P. Pulman. 12mo, Lond. 1840. 3d edit. 1851. The Moor and the Loch, by John Colquhoun. 8vo, Edinburgh, 1840.

Anglo-Calvinists.

Two Summers in Norway, by the author of *Angler in Ireland.* 2 vols. post 8vo, Lond. 1840. Treatise on Salmon and Trout Angling, by J. D. Dougall. 12mo, Lond. 1841. River Dove, with some quiet thoughts on Angling. 12mo, Lond. 1841. Fly-Fisher's Text-Book, by Thomas Smith. 8vo, Lond. 1841. The Practical Angler, by Picarton. 8vo, Lond. 1842 and 1843. Art of Angling and Complete System of Fly-Making and Dying of Colours, by W. Blackie. 12mo, 1842. Days and Nights of Salmon Fishing, by William Scrope. Royal 8vo, 1843. True Enjoyment of Angling, by Henry Phillips. 12mo, Lond. 1843. The Rod and the Gun, by James Wilson, F.R.S.E., and by the author of *The Oakleigh Shooting Code.* 1st edit. 1840. 2d edit. 1844. Practice of Angling, particularly for Ireland, by O'Gorman. 2 vols. post 8vo, Dublin, 1845. The Art of Angling, &c., by Thomas Best. 32mo, Lond. 1846, 13th edit. Hints on Angling, Angling Excursions, &c., by Palmer Hackle. 8vo, Lond. 1846. Trout Flies of Devon and Cornwall, by G. W. Soltau. Post 8vo, Lond. 1847. The Angler's Companion to the Rivers, &c., of Scotland, by T. S. Stoddart. Post 8vo, 1847. 2d edit. 1853. Adventures of an Angler in Canada, Nova Scotia, &c., by C. Lanman. Post 8vo, Lond. 1848. Angler's Assistant, by William Carpenter. 12mo, Lond. 1848. Angling Reminiscences, by Thomas Tod Stoddart. 12mo, Lond. 1848. The Handbook of Angling, by Ephemera (*i.e.* Fitzgibbon). 12mo, Lond. 1848, 2d edit. Guide to Norway, or Salmon Fisher's Companion, by John Jones. 12mo, Lond. 1848. Edited by G. F. Tolfrey. Breeding, Rearing, &c., by Gottlieb Boccius. 8vo, Lond. 1848. The Rod and the Line, by Hewett Wheatley, Senior Angler. 12mo, 1849. Practical Fly-Fishing founded on Nature, by Arundo. 12mo, 1849. Rocks and Rivers, or Highland Wanderings, by John Colquhoun. Post 8vo, Lond. 1849. Fly-Fisher's Entomology, by Alfred Ronalds. 8vo, Lond. 1849, 4th edit. Fish and Fishing in the United States, by H. W. Herbert. 8vo, Lond. 1849. Spring-Tide, or the Angler and his Friends, by T. Y. Akerman. 12mo, Lond. 1850. The Book of the Salmon, in two parts, by Ephemera, assisted by Andrew Young. Post 8vo, 1850. The Erne, its Legends, and its Fly-Fishing, by Henry Newland. Post 8vo, Lond. 1851. Fly-Fishing in Salt and Fresh Water, with Plates. 8vo, Lond. 1851.

The preceding extensive list will probably suffice for the instruction and guidance of the most studious angler. Those who are curious in regard to bibliographical details concerning the different editions of the earlier works may consult a *Catalogue of Books on Angling*, 8vo, 1811, published by Mr Ellis of the British Museum, and originally printed in the *British Bibliographer*. (J. W.)

Explanation of Plate XLI.

Fig. 1. Salmon-fly for spring.
2. Ditto ditto.
3. Ditto ditto.
4. Ditto for summer.
5. Ditto ditto.
6. Ditto for spring.
7. May-fly.
8. Red-brown fly.
9. Green-drake fly.
10. Ditto.
11. Dun cut fly.
12. } Minnow-tackle
13. } hooks, baited.
14. Moth-fly.
15. Palmer-fly.
16. Ditto.

Fig. 17. Ant-fly.
18. Hawthorn-fly.
19. Minnow-tackle.
20. Gorge-hook and baiting-needle.
21. Dead-snap, with four hooks.
22. Dead-snap with two hooks baited.
23. Live bait double hook, baited.
24. Gorge-hook, baited.
25. Live bait single hook, baited according to two different methods.

ANGLO-CALVINISTS, a name given by some writers to the members of the Church of England, as agreeing with the other Calvinists in most points except church government.

Anglo-Saxon ‖ Angola.

Anglo-Saxon, an appellation given to the language spoken by the English Saxons, in contradistinction to the true Saxon, as well as to the modern English.

ANGLUS, Thomas. See White, Thomas.

ANGOLA, or Dongo, a territory on the western coast of Africa, between 8° and 10° south latitude. It has Congo on the north; the South Atlantic Ocean on the west; Benguela on the south; and the African States of the interior on the east. It extends about 350 miles from east to west, and between 50 and 60 miles from north to south.

Angola is very mountainous, being destitute of plains except on the sea-shore, and some small plateaux on the sides or in the gorges of the mountains. It is well watered, and, with the exception of the sandy plains on the coast, is very fertile. Its principal rivers are the Coanza, which forms its boundary on the south; the Danda, which bounds it on the north; and the Benga. Here, as in all well-watered tropical countries, vegetation is most luxuriant: palms, the citron, orange, lemon, banana, cocoa, tamarind, mangrove, sugar-cane, vine, and indeed every species of tropical vegetation, is found in great abundance. Nor is the animal kingdom less prolific: all the animals common to inter-tropical Africa are found here, with some peculiar to this part of the country. The sheep, cow, and horse, have been imported from Europe. Its birds are very numerous, and among its reptiles are many of the most venomous. Of its mineral productions, lead, sulphur, petroleum and iron, are plentiful; gold and silver are found in the mountains, and copper is said to exist in the interior. The heat is moderate, and the climate mild and salubrious. Its population is estimated at between two and three millions.

The habitations of the natives are formed merely of straw, or rather of dried leafy plants, cemented by a framework of wooden stakes. Containing no aperture for the admission of light, they form not so properly houses, as dark dens for sleeping in, while the tenants spend the day and receive company in an open space in front, covered with a slight roof. The abodes of the grandees are in no respect superior, except that they consist of a number of these hovels grouped together, and inclosed by a hedge or earthen wall. A village or town consists merely of a cluster of these inclosures, separated by narrow and winding footpaths, and leaving extensive open spaces, which serve for markets or for scenes of recreation. A town in this country at a little distance resembles a wood, from the multitude of trees with which it is filled; but on a near approach its nature is soon detected by the fetid odour exhaling from its precincts.

Like other unenlightened tribes, the natives are deeply addicted to superstition; and it is remarked as a singular circumstance, that their idols do not present the negro visage, but one more nearly approaching to the European. From the slight description that is given, we should suspect the face to be Copt; nor does it seem improbable that the superstitions of Egypt may have found their way throughout the continent. The priests pretend to bestow rain, favourable winds, and various other blessings, upon those who have propitiated them by liberal gifts. Much use is made in criminal cases, of what our ancestors called "the judgments of God." The accused is made to swallow poison, to plunge into water, or to take in his hand burning coals, and, unless he escapes unhurt from these trials, is at once pronounced guilty. It seems reasonably concluded, that the priests who administer these tests contrive to secure immunity to their favourites, or to those who bestow upon them liberal donations.

Vessels destined for the coast of Angola, after reaching Cape Verde, have two routes by which they may proceed.

They may take the *short* route by steering directly along the African coast, through the Gulf of Benin. If favoured by winds and currents, they may make this voyage very speedily; but in the event of these circumstances proving adverse, they are liable to great detention; and the navigation has even occupied eleven months. The other, called the *long* route, is performed by proceeding due south, and even south-west, till they pass the 20th degree of latitude, when a favourable wind and tide carries them directly eastward to the African coast. This route necessarily occupies a considerable time; but is liable to no vicissitude, and the period may be calculated almost to a day.

Angola was discovered in 1484 by Diego Cam, a Portuguese, and soon afterwards several settlements were established there by that government. When Portugal had possession of Brazil, an active slave-trade was carried on with this country; but at present the Portuguese derive little or no benefit from the possession of Angola. They have a governor at the chief town, St Paul de Loando, and possess a few decayed forts in the interior, but have little authority in the country. The principal exports are ivory and gum. (See Bowdich, *Account of the Discoveries of the Portuguese in Angola, &c.*, 1824. G. Tams, *Die Portugiesischen Besitzungen in Süd-West-Afrika.* Hamburg, 1845.)

ANGON, in the *Ancient Military Art*, a kind of javelin used by the French. They darted it at a considerable distance. The iron head of this weapon resembled a fleur-de-luce. It is the opinion of some writers that the arms of France are not fleurs-de-luce, but the iron point of the angon or javelin of the ancient French.

ANGORA, or Enguri (the Ancyra of the ancients), a town of Natolia, capital of a sandjak of the same name. It stands on an eminence 140 miles north of Konieh, in Lat. 40. 2. N.; Long. 33. 5. E. Its population is variously estimated at from 20,000 to 60,000, including Mahometans, Armenians, Greeks, and Jews. There are still to be seen remains of the celebrated *Monumentum Ancyranum*, a temple of white marble erected by the inhabitants in honour of Augustus, who improved and embellished the city. On the walls of this temple is an inscription in Greek and Latin, a great part of which is still legible, detailing the principal events in the life of Augustus.—(See *Hamilton's Researches in Asia Minor*, &c., 1842.) Angora has long been celebrated for its breed of goats, which annually yield about 500,000 okes (11,200 cwt.) of hair for exportation. Among its exports are also wheat, opium, gum, wax, and honey. In its vicinity are many fine gardens.

Ancyra originally belonged to Phrygia, and afterwards became the chief town of the Tectosages, one of the three Gallic tribes that settled in Galatia about B.C. 277. In B.C. 189 Galatia was subdued by Manlius, and in B.C. 25 it was formally made a Roman province, of which Ancyra was the capital. On the division of Galatia by Theodosius I. or Valens, Ancyra became the capital of Galatia Prima. It was the seat of one of the earliest Christian churches founded probably by the apostle Paul; and a council was held here in 315. In 1402 a great battle was fought in the vicinity of Ancyra, in which the Turkish sultan Bajazet was defeated and made a prisoner by Tamerlane, the famous Tartar conqueror. In 1415 it was recovered by the Turks under Mahomet I., and since that period it has always belonged to the Ottoman Empire.

ANGORNO, a town of Bornou, in Central Africa, on the south-west bank of Lake Tsad. It is said to have a population of 30,000, which is increased to thrice that number during the weekly markets, when a great traffic is carried on in cotton, amber, coral, metals, and slaves.

ANGOSTURA, a city of South America, in the republic of Venezuela. Lat. 8. 8. 10. N. Long. 63. 55. 20. W. It stands on the south bank of the Orinoco, about 240 miles from its mouth. It is favourably situated for commerce, being in a very fertile district, and the river is navigable for vessels of 300 tons up to the town. In the year 1841–2, 419 vessels entered and left its port, of the aggregate burthen of 29,863 tons. The value of its imports for that year is said to have been L.63,353; of its exports L.115,831. It has a large city hall, an hospital, and a college, and is defended by a fort on the opposite side of the river. Pop. in 1846, 10,000.

ANGOT, a considerable province in the southern part of the kingdom of Abyssinia. See Abyssinia.

ANGOULEME (the *Iculisma* of the ancients), a city of France, capital of an arrondissement of the same name, and of the department of Charente. It stands on an elevated plateau on the left bank of the Charente, 221 feet above the river, and on the railway between Paris and Bourdeaux, 66 miles north-east of the latter. It is the seat of a bishop, a court of assize, and a tribunal of primary jurisdiction; and has a public library, a royal college, an obstetric school, a theatre, a museum of natural history, and a society of agriculture, arts, sciences, and belles-lettres. Angouleme is, in general, well built; but many of the streets in the old town are narrow and crooked. It has numerous paper-mills, a cannon foundry, an extensive powder-mill, manufactories of linen, cloth, and porcelain, besides a considerable general trade, particularly in wine and brandy. The chief public buildings are an ancient castle, a cathedral, and a fine bridge over the Charente. Pop. in 1846, 18,482. The arrondissement of the same name is divided into nine cantons, and 143 communes; and by the census of 1846 contained 136,653 inhabitants.

ANGOUMOIS, an old province of France, now forming the department of Charente and part of that of Dordogne. Its capital was Angouleme.

ANGOY, or Engoy, a small province in the country of Congo, which nearly two centuries ago rendered itself independent. It extends along the northern bank of the Congo or Zaire, from its junction with the sea inwards. A great proportion of the surface is covered with forests and swamps: cultivation has made little progress, and the population is thin. Bomangoi, in the interior, is stated to be the capital; but Cabenda, near the mouth of the Zaire, is the seat of trade, and dealt largely in slaves previous to the prohibition of that traffic.

ANGRA, a city of Terceira, one of the Azores; the capital of that group, and the residence of the governor. It is seated on the southern shore, and its harbour is the only tolerable one in the whole island. It is in the form of a crescent, the extremities of which are defended by two high rocks, that run far into the sea, and render the entrance so narrow as to be easily covered by the batteries on each side. From this harbour the town is said to derive its name; the word *Angra* signifying a creek, bay, or station for ships. Here ships may ride in perfect safety during the summer; but as soon as the winter begins, the storms are so furious, that the only safety is in putting to sea with all possible expedition. Happily these storms are preceded by infallible signs, with which experience has made the inhabitants perfectly acquainted.

The town is well built and populous, and forms the see of a bishop, under the jurisdiction of the archbishop of Lisbon. It contains five parishes, a cathedral, four monasteries, as many nunneries, besides a bishop's court, which extends its jurisdiction over all the Azores. The fortifications have lately been considerably extended. Pop. 13,000.

At Angra are kept the royal magazines for anchors, cables, sails, and other stores for the royal navy, and occasionally

for merchant vessels in great distress. All maritime affairs are under the inspection of the *Desembergador*, an officer who has subordinate officers and pilots for conducting ships into the harbour, or to proper watering places. The English, French, and Dutch, have each a consul residing at Angra, though the commerce of these nations with the Azores is very inconsiderable. Long. 27. 14. W. Lat. 38. 38. N.

ANGRI, a town in the province of Principato Citeriore, kingdom of Naples, with 6400 inhabitants.

ANGUIER, François and Michel, two brothers, natives of Normandy, were distinguished sculptors in the time of Louis XIV. Michel, the younger of the two, executed the sculptures of the triumphal arch at the Porte St Denis. A marble group of the *Nativity* was reckoned his masterpiece.

ANGUILLA, or *Snake Island*, the most northern of the Leeward group. Lat. 18. 14. N. Long. 63. 8. W. Its chief productions are sugar, cotton, maize, tobacco, and salt. Pop. about 3000.

ANGUILLARA, Giovanni Andrea dell', one of the most distinguished Italian poets of the sixteenth century, was born at Sutri in Tuscany about the year 1517. His free translation of the *Metamorphoses* of Ovid in *ottava rima* still enjoys a high reputation in Italy, and some admiring critics have even preferred it to the original.

ANGUINUM OVUM, a fabulous kind of egg, said to be produced by the saliva of a cluster of serpents, and possessed of certain magical virtues. The superstition in respect to these was very prevalent among the ancient Britons, and the traditionary belief on the subject still exists in Wales. This wondrous egg seems to be nothing more than a bead of glass, used by the Druids as a charm to impose on the vulgar, whom they taught to believe that the possessor would be fortunate in all his attempts, and that it would gain the favour of the great.

ANGUS, the old name of the county of Forfar. It gave the title of Earl to the Douglasses; and now to the Duke of Hamilton. See Forfar.

ANGUSSOLA, or Angosciola, four sisters, named Sofonisba, Lucia, Europa, and Anna Maria, distinguished painters, who flourished in the latter half of the sixteenth century. They were members of a noble and ancient family at Cremona. The merit of the younger sisters, though considerable, was eclipsed by that of Sofonisba, who ranks as one of the best portrait painters of that period. She also painted some small historical pieces, which are highly esteemed. She was born in 1533, and was twice married. In 1560, at the invitation of Philip II., she visited the Court of Madrid, where her portraits elicited great commendation. She was blind and infirm at the time of her death, which happened at Genoa in the 93d year of her age. Vandyke is said to have paid her the high compliment of declaring that he had derived more knowledge of the true principles of his art from the conversation of that blind woman than from any other source. She painted several fine portraits of herself, one of which is now at Althorp. (*Vasari; Fuseli's Pilkington; Lanzi.*)

ANGUSTICLAVIA, in *Roman Antiquity*, a tunica worn by the equestrian order, having two narrow purple stripes inwoven parallel to each other, and extending from the shoulders down its entire length. The Laticlavia Tunica, worn by the senators, was loose at the waist, and distinguished by one broad purple band which extended perpendicularly from the neck down its centre. The *Latus Clavus* is said to have been introduced at Rome by Tullus Hostilius after his conquest of the Etruscans, and it appears to have been worn in early times by all classes promiscuously. It seems that Augustus sometimes conferred the privilege of wearing the Latus Clavus on the children of equestrians, as a prelude to entering the senate.

ANHALT, Duchies of, in Germany, lie between Lat. 51. 33. and 52. 7. N., and Long. 11. and 12. 36. E., and comprise an area of 1017 square miles. They are almost entirely surrounded by the Prussian province of Saxony. The country is generally level, having few elevations except where the Hartz Mountains project towards Bernburg. The land, which is in a high state of cultivation, is very fertile, and is watered by the Elbe and its tributaries the Mulde, the Nuthe, and the Saale, which last receives here the Wipper and the Bode. The inhabitants are chiefly engaged in agriculture and the rearing of sheep and cattle, for which the extensive forests and rich meadows are very favourable. The productions of the country are corn, wine, tobacco, flax, hops, and fruits; and its manufactures linen, cotton, and woollen goods, metallic and earthen wares. These find a ready exit by means of the Elbe and the Magdeburg-Leipzig, and the Anhalt-Berlin railways. Game and fish are abundant, and the mountains are rich in minerals.

Anhalt still exists as a consequence of that ancient system of hereditary succession in which the right of primogeniture was not recognised, the younger children sharing also in the heritage. Hence arose those petty kingdoms and principalities, of which several still exist in Germany. Whatever advantages this system may have had, it certainly tended much to retard the diffusion of civilisation and prosperity.

Bernhard, son of Albert surnamed the Bear, was the first who obtained the title of Prince of Anhalt, which territory he held, together with a great part of the Duchy of Saxony On his death in 1211 he was succeeded in the principality of Anhalt by his son Henry I.; while Albert, a younger son, received his possessions in Saxony. On the death of Henry in 1252, Anhalt was divided among his family into three parts, which were afterwards united under Ernest Joachim I., who reigned from 1570 to 1586. On his demise the country was again divided among his four sons into Dessau, Bernburg, Coethen, and Zerbst. The Zerbst family dying out in 1793, their possessions fell to the share of the other three. By the death of Henry Duke of Anhalt-Coethen in November 1847, that line became extinct, and the affairs of the Duchy are now administered by the Duke of Anhalt-Dessau, for behoof of himself and the Duke of Anhalt-Bernburg. In 1807 the princes of Anhalt took the title of dukes, and joined the Confederation of the Rhine. In the Germanic Confederation the three duchies, in conjunction with Oldenburg and Schartzburg, have the fifteenth vote in the ordinary diet; but each has a distinct vote in its plenary assemblies. The population of Anhalt is almost entirely Protestant.

Several of the princes of Anhalt have borne a conspicuous part in the affairs of Europe, and not a few of them have been noted for their zeal in the cause of Protestantism. Wolf or Wolfgang VI., Prince of Anhalt-Coethen, and Joachim I., of Anhalt-Dessau-Zerbst, distinguished themselves in the cause of the Reformation. They were present at the diet of Augsburg in 1530, and Wolfgang was one of those who presented the "Confession" to the emperor.

Anhalt-Bernburg, the most western of the three duchies, has an area of 339 square miles, and is divided into two separate duchies. The upper duchy lies on the side and at the foot of the Hartz Mountains, and though generally mountainous and woody, it has some fine valleys. The lower duchy, situated on the Saale and Elbe, is generally flat, and in some parts marshy. The climate of the lower duchy is temperate and mild, while that of the upper is cold and humid. The mines in the neighbourhood of the Hartz Mountains yield copper, silver, iron, lead, sulphur, and gypsum. It is divided into nine amts or bailiwicks, each of which has a chief town of the same name, viz., Bernburg, Plötzkau, Mühlingen, and Koswick, in the lower duchy; and Bal-

lenstedt, Hartzgerode, Günthersberge, Gernrode, and Hoym, in the upper. The revenue for 1851–2 amounted to 808,888 thalers, about L.121,333, and the expenditure was 806,828 thalers, or L.121,024.

It has some mediatised possessions in the province of Saxony. Pop. in 1849, 50,411; of whom 837 were Jews. This duchy furnishes a contingent of 370 men to the Germanic Confederation, and has a standing army of 300 men. The public debt amounts to 2,100,000 thalers, or L.315,000.

Anhalt-Coethen has an area of 318 square miles, and consists of four distinct parts intermingled with the territories of surrounding princes. The most compact part is that which lies around the capital, and the most distant lies on the right bank of the Elbe. It is generally a level plain, with a sandy soil, but for the most part well cultivated and very productive. It is divided into six amts, viz., Coethen, Neinsdorf, Wulfen, Nienburg, Warmsdorf, and Roslau. Population in 1849, 43,120, almost all engaged in agricultural and pastoral pursuits. The possessions of this duchy in Southern Russia comprise an area of 230 square miles. The principality of Plesse in the Prussian province of Silesia, which was held by the late duke, passed, at his death, to the Count of Hochberg. The revenue and expenditure for the year 1851–2, were respectively 449,888 thalers, or L.67,483. It furnishes to the federal army a contingent of 325 men.

Anhalt-Dessau, the most eastern of the three duchies, has an area of 360 square miles. It is intersected by the Elbe and the Mulde. The greater part of it is very fertile and well watered, and is well cultivated. Population in 1849, 63,700. Its mediatised possessions have an area of about 200 square miles, with 12,000 inhabitants. It is divided into seven amts, viz., Dessau, Oramnibaum, Quellendorf, Gröbzig, Sandersleben, Alsleben, and Zerbst, each of which has a chief town of its own name. It furnishes a contingent of 529 men; and its revenue and expenditure are equal, each being in 1851–2, 596,000 thalers, or L.89,400. Anhalt Dessau and Coethen have a standing army of 1000 men; and a public debt of 3,500,000 thalers or L.525,000, of which last rather more than two-thirds belongs to Coethen.

ANHOLT, a Danish island in the Cattegat, 32 miles north-east of Greenæ, and 36 south-east from Lessoe. It is a barren spot, scarcely affording subsistence to 200 inhabitants, who, from their language, which is Celtic mixed with a few Danish words, are supposed to be emigrants from the Highlands of Scotland. Their chief pursuit is fishing. The occupation of this island was a subject of contest with England during the war. It is surrounded by dangerous banks of sand, for which reason a lighthouse is built on its most easterly promontory, in Lat. 56. 44. 20. N. Long. 11. 38. 51. E.

ANIANI Breviarium. See Civil Law.

ANICHINI, Luigi, an engraver of seals and medals, born at Ferrara in the sixteenth century. Michael Angelo pronounced his *Interview of Alexander the Great with the High-Priest at Jerusalem* "the perfection of the art." His medals of Henry II. of France and Pope Paul III. are greatly valued.

ANIELLO. See Massaniello.

ANIMAL. See Animal Kingdom.

Animal-Flower, a name applied to certain species of the genus *Actinia*, remarkable for the brilliant colours which ornament their tentacula, and which produce an appearance resembling the variegated corolla of a plant. The name is of vicious construction, and is falling into disuse. See Zoophytes.

ANIMAL KINGDOM.

We embrace the earliest opportunity afforded by our alphabetical arrangement to present a few introductory observations in illustration of a science unrivalled in interest, and not greatly surpassed in importance by any department of human knowledge. Zoology, or the science which treats of the nature and history of animals (from ζωον, *an animal*, and λογος, *a discourse*), embraces so vast a field of observation, that although it cannot be regarded otherwise than as a single and beautifully connected science, its great extent of general doctrine, and multiplied variety of details, render necessary a subdivision into many branches, each of which, if worthily followed, is in truth more than sufficient to occupy the undivided attention of the most zealous votary. If in voluminous works exclusively devoted to natural history a single department of the science usually engrosses the entire attention of an author, it is evident that, in the present publication, it would not only be in vain to attempt a complete exposition of the subject under a single head, but that even the various treatises under which its different branches will be exhibited must be presented in a very abridged and compendious form. It shall be our endeavour, however, in the course of our natural history treatises, so to select and methodize the great leading facts of the science, as to enable our readers to form an accurate idea of the present state of zoological knowledge, even though certain minuter details, hitherto forming too conspicuous a feature of the subject, yet not essential to its truthful representation, should in some measure be curtailed.

With a view to obviate to a certain extent the inconvenience arising from the disconnection of the different parts of the science, which the nature of an alphabetic encyclopædia necessarily occasions, we now propose, under the words *Animal Kingdom*, to give 1*st*. an exposition of such of the general doctrines of zoology as, not pertaining more to one department than another, may with the greater propriety be separated from the history of particular classes, and presented as a useful and appropriate introduction to the whole,—thus uniting the advantages of an alphabetical and systematic arrangement; 2*dly*, to present outlines of some of the prevailing systems of zoology, so as to exhibit in a condensed form the general principles of classification, and enable the student more clearly to understand the relative connections which exist between the scattered treatises in which the subjects (in their alphabetical order) will be afterwards more fully developed; and 3*dly*, to give a sketch of the arrangement to be followed during the future progress of this work, which will not only serve as a guide or general index to the separate articles, but will, on the completion of the Encyclopædia, enable the attentive reader to methodize these articles in such a manner as to form a complete and consistent system of zoology.

It is by no means so easy as it may at first appear, to define precisely what is meant by the term *animal*, because, as we descend in the scale of beings, we find a transition so gradual from those whose powers and properties are strongly characterized, to others which, along with a scarcely perceptible share of sensation and voluntary motion, partake so greatly of the nature of plants, that the most acute naturalists have varied in opinion regarding the exact line of their demarcation. There are also many plants which appear to differ less from certain animals than they do from other plants of an opposite nature and construction. This connected series of organized bodies, however, is not graduated after the mode established by some vague writers on natural history

for it is not the most perfectly composed, but rather the least complex plants, which follow the most simply organized animals. It has been said that nature follows a continuous and ascending chain, from the mineral to the plant, and from the vegetable to the animal kingdom, the apex of which is crowned by the most perfect work of creation,—the human race. Certain minerals, such as amianthus or asbestos, no doubt exhibit a fibrous or woody structure; and coral, which has a stony texture, a vegetable form, and polypus inhabitants, has been adduced in illustration of the union of the three kingdoms.[1] But all such fanciful speculations are the result of partial and inaccurate observation. The calcareous basis of the coral is formed by a species of polypus, and has no more principle of increase in itself than the shell of the oyster or the waxen cells of the honey-bee. Its elegant branches are created by the instinctive labours of the animal inhabitants, which alone are possessed of life. The animal and vegetable kingdoms are more correctly compared to two great pyramids, intimately united at their bases, but diverging more and more as they ascend.

The extraordinary beings which by their ambiguous nature may be said to have thus blended two kingdoms into one, are called zoophytes or animal plants. They were arranged by Tournefort among vegetables, and were at an after-period removed to the class to which they really belong, chiefly on the authority and through the labours of Linnæus and Pallas. These naturalists bore in mind what few of their predecessors seem to have remembered, that locomotion, that is to say, the movement of a body from place to place *en masse*, though a general characteristic, is not an essential or indispensable attribute, of animality; for numerous animals of the molluscous and radiated kinds are as permanently fixed to their native rocks and coral reefs as the most deeply rooted plants are to the soil which gave them birth.

As sensation and the power of voluntary movement, in whole or in part, are the principal characteristics of animals, it is evident that the more these faculties become developed, the greater will be their removal from the vegetable kingdom. The more perfect the plant, and the more complicated the animal becomes, the greater disparity will be perceived to exist between them. If, in distinguishing the animal from the vegetable, nothing more were required than to point out the differences between an oak and an elephant, the line of demarcation would be easily drawn, and the characters of the respective classes could never more be confounded. But there are many plants which, though less aspiring than the oak, lay claim to a closer alliance to a higher kingdom; and many animals of a more carnivorous nature than the elephant are much more nearly connected by their nature and attributes with the vegetable tribes. When we perceive a living or animalized substance producing by suckers, buds, or offsets from its own body,—when we see that by the influence of light, air, and humidity, it is rendered capable of re-assuming the functions of vitality after a long period of suspended animation and apparent death,—when we ascertain that it cannot live except in water, or when saturated with moisture,—and that although it may be capable of certain languid and partial motions, it is yet fixed for life to a single point of space, where it derives its nourishment by means of external pores,—we have certainly the description of an animal of the lowest order, which applies at the same time almost equally well to vegetable life.

The following were the dicta of Linnæus in relation to the three kingdoms of nature:—"Minerals grow; vegetables grow and live; animals grow, live, and feel." The only character common to these kingdoms, according to the above definitions, is that of growth, or the power of adding to previous bulk. "The vegetation of stones," it is observed by the late bishop of Llandaff, in his *Chemical Essays*, "hath been admitted by many; and some have contended that minerals, as well as animals and vegetables, *spring from seed*, the greatest being nothing but the expansion of the parts of a minute grain of sand." But mineral bodies in truth cannot be said to grow. They receive by aggregation or superposition, by mechanical or chemical agency, an increase of particles. Tournefort, indeed, was of opinion that stalactites in caves actually increased by an internal growth or propulsion like that of plants and animals. But it is known that these concretions add to their bulk by successive depositions of stony particles contained in the water which bathes their sides or percolates through the canal by which their centres are frequently perforated. They possess no attribute which bears the slightest affinity to that internal life which propels the fluids or assimilates the nutritive juices in the animal and vegetable kingdoms. Minerals, then, are destitute of that active power by which animals and plants effect an individual appropriation of such materials as conduce to their nourishment and increase, and which is carried on, not by casual juxtaposition, or the addition of similar particles previously prepared, but by an admirable and elaborate process, through which the ponderous bullock, with its immense load of fleshy fibre, converts into its own muscular and sanguiferous system the sweet-smelling grass of the meadow; and through which also the size and flavour of our most delicious fruits are often primarily derived, from an addition to their natural soil of substances of a very different and less inviting nature. Romé de Lisle has accurately observed that straight lines and plane surfaces are characteristic of mineral bodies, but that animals and plants are composed of curved lines or rounded surfaces, resulting from that central power of life which dilates the internal organs in all directions, and tends to produce spherical or cylindrical forms. The seeds of plants, the eggs of birds, and the young of all animals, are remarkable for the roundness of their outlines.

The objects of natural history, however, are not now divided into three kingdoms; for the characters which connect together plants and animals on the one hand, and distinguish both of these kingdoms from minerals on the other, are so obvious and strongly marked, that the divisions now established are those of *organic* and *inorganic* bodies; the former including all animals and plants, the latter all mineral substances. The definition of an animal, given by M. Virey, is as follows: *A being, organized, sensible, endowed with voluntary motion, and provided with a central organ of digestion.* And he thus defines a plant: *A body, organized, insensible, not endowed with voluntary motion, nourished by external pores.* To these he adds another character, that the reproductive organs of plants are developed and thrown off every year, whereas those of animals are persistent. It is evident that the last clause of his first definition—that which relates to the central organ of digestion—if rigorously applied, would exclude a number of the infusorial tribes from the animal kingdom.

Perhaps the most efficient mode of distinguishing between animals and plants is by having recourse to a certain range of characters, derived from the study of their

[1] Virey, *Mœurs et Instinct des Animaux.*

internal structure and organic functions: thus the possession of nerves, muscles, and a stomach, with the consequent attributes of *sensation*, *voluntary motion*, and *digestion*, will be found to separate animals properly so called from all other organized matter. If these leading characters are not common to all animals, they are at least proper to them alone; and if the whole of these characters are not always united in the same animal, we invariably find at least one of the three. Thus certain species of polypus, the sensibility and voluntary movements of which cannot be said decidedly to manifest themselves, are obviously furnished with a digestive cavity or stomach; and many of the infusory animals, of the digestion of which we know nothing, are as perfect in regard to their varied powers of locomotion as any of the higher classes. Numerous zoophytical species, indeed, are of so simple a nature, that in them we cannot perceive either a distinct tissue or a nourishing fluid; but we can form some opinion of the nature of their elements from the character of their properties. Irritability indicates nerves, motion supposes the existence of muscles, and the continued maintenance of life attests nutrition. Thus the materials of animal life, so vaguely constituted in these creatures, are detected by their general properties.

In relation to their chemical characters, animals may be said to be principally composed of azote; and vegetables, with the exception of cruciferæ, of carbon. Animals absorb oxygen, plants disengage it; the former reject carbon, the latter become impregnated with it. An exchange of principles is thus effected between the two great divisions of organized existence; but it has been observed that plants merely fix or organize carbon, whereas animals appear to transform into azote, both the air which they respire, and the aliments by which they are nourished.

It has been asserted that a *single mouth*, or opening to the digestive canal, sufficiently characterizes animals from plants, as the latter always possess innumerable pores, which with them are the representatives of the mouth, and conduce to the same ends; but this distinction is in fact inaccurate, as some species of Fasciola possess two mouths, certain Tristomæ three, and the genus called by Cuvier Rhisostoma many more; to say nothing of the infusorial tribes, many of which have no mouth at all, but derive their nourishment by imbibition through the medium of external pores. Nutrition, or the power of deriving nourishment from other bodies, is common alike to plants and animals, and effects for organized and living bodies that increase of bulk which inorganic or disorganized substances can only attain through the medium of an affinity of particles, or by mechanical aggregation. The functions of nutrition, however, as manifested in the animal and vegetable kingdoms, are very differently performed in each. Fixed for ever to the soil which gave them birth, plants are rendered incapable of searching after nourishment by a voluntary change of place, but derive their chief support from roots, the pores of which absorb the nutritive portions from the humid soil, and by a uniform and continuous action, which is only interrupted by an absence of the necessary moisture. The generality of animals, on the contrary, being possessed of the power of locomotion, are also endowed with the capacity of transporting with themselves a supply of necessary nourishment; for which purpose they are provided with an internal cavity or stomach, the inward surfaces of which are provided with absorbing pores, which Boerhaave expressively named *internal roots*. "The magnitude of this cavity," observes Cuvier, "in a number of animals, permits them to introduce solid substances into it. It was necessary then that they should have instruments for dividing those substances, and liquors for dissolving them. In a word, with such animals nutrition does not immediately commence upon the absorption of the substances which the soil or the atmosphere furnishes. It is necessarily preceded by a vast number of preparatory operations, the whole of which constitute *digestion*."[1] The motion of the nutritive fluid in plants, from the simplicity of their structure, and the fixity of their position, seems to be preserved by simple external agents. "It appears to proceed upwards by the effect of their spongy or capillary texture; and the evaporation which takes place at their top, and its motion in that direction, is the more rapid in proportion as the evaporation is great. It appears also that the motion of this fluid may even become retrograde, when it ceases to flow in its usual course, or changes into absorption by the coldness and humidity of the atmosphere."[2] In regard to animals, however, the case is different. Being destined continually to change their localities, and to live exposed to a variety of temperatures, they require an active principle within themselves for the conveyance of their nourishing fluid. This fluid is therefore contained in a multiplicity of canals, which are ramified from two trunks, communicating with each other in such a manner that the roots of the one, called the venous system, receive the contents which the other, known as the arterial system, has propelled to the extremity of its branches, and restore them to the centre, from which they are again driven forward. It is this rotation which constitutes what is called the circulation of the blood. It may be regarded as a function of a secondary order proper to animals, but not universal to that kingdom, as it depends in a great measure on the existence of that central organ called the heart, of which some classes are entirely destitute. It is therefore less essential to life than digestion, and not so intimately related to the faculties of sensation and locomotion. In regard to respiration, animals which are unprovided with a regular circulating system respire, like vegetables, over the whole of their surface, or by various vessels which are placed at different points, and convey the air to the interior of their bodies. "No animals," says Cuvier, "respire by a particular organ, except such as have a real circulation; because in them the blood coming from one common source, the heart, to which it constantly returns, the vessels that contain it are so disposed that it cannot arrive at the other parts until it has passed through the lungs. This, however, cannot take place in vegetables, or in those animals in which this fluid is everywhere diffused in a uniform manner, without being contained in vessels." Pulmonary or branchial respiration is therefore an animal function of a third order, invariably connected with circulation, and one degree removed from such faculties as are essential to animal life.

When a vegetable dies of old age, it begins to decay in the centre. We frequently see ancient willow-trees entirely dead, except in a few slender twigs, or in small portions of their superficial bark. An animal, on the contrary, first dies in its extremities and circumference, whilst the heart or central portion continues for a time to perform, however languidly, its accustomed actions.

Among plants both sexes usually occur in the same individual, or even on the same flower; but in a far greater proportion of animals the two sexes are represented by separate individuals. There is indeed no genuine hermaphrodital union among mammiferous animals, birds, reptiles, fishes, cuttle-fish, crustacea, or in-

[1] *Lectures on Comparative Anatomy*, lecture i.

[2] *Ibid.*

sects. Among many molluscous animals, however, such as the oyster and other bivalves, both sexes are found on the same individual, which is consequently sufficient of itself for the purposes of reproduction, and may be regarded as a genuine hermaphrodite. This singular order of things is in fact indispensable to the nature of bivalve testacea, which, being almost entirely deprived of the power of locomotion, and destitute of eyes or other organs by which to distinguish each other, require to possess within themselves the power of reproduction, lest their kind should cease. The species is both represented and continued by a single individual. In the earthworm, again, the same union of the sexes occurs, but modified in such a way that the concurrence of two individuals is required for the continuance of the race, and each acts in relation to the other both as male and female. This is also the case with slugs, and a great proportion of univalve and turbinated shells. Lastly, the zoophytical animals are not distinguished by any sex, but are multiplied by separation or excision of parts of their own bodies.

The law which establishes a perfect distinction and separation of the sexes in animals seems likewise to produce a double and symmetrical structure, and is of great extent in that kingdom; whilst the circular or radiated form more especially distinguishes plants, and is also characteristic of those zoophytical tribes which, both by name and nature, claim an alliance to the vegetable world.

The grain, and the fruit or kernel, may be said to bear the same relation to a vegetable as the egg or the embryo does to an animal,—with this difference to be borne in mind, that the concurrence of the sexes is necessary to the formation of the vegetable egg, whereas in the animal kingdom that circumstance is indispensable only to the fecundation of the pre-existing germ. The perfection of a plant, and the ultimate aim of its existence, if we may use such a phrase to an inanimate structure, consist in the continuance of its kind. In such as are named *annuals* especially, the term of whose existence is limited in many instances to a small portion of the year, the ripening of the seeds is speedily effected, and, after a very brief period, death succeeds " the bright consummate flower." In numerous tribes of insects the same fleeting existence is observable, though the ephemeral nature of these last-named tribes is rather apparent than real, as the wonderful metamorphoses to which they are subjected conceal their identity from the eye of the uninitiated, and greatly interfere with a continuous tracing of the same individual from the egg to the perfect form. For example, many aquatic flies, such as the Ephemeræ and others, whose declared and more obvious existence does not exceed a few hours, have, previous to their assuming the winged state, spent months or even years in the banks of rivers, and beneath the surface of the stream.

Even the mode of reproduction among the lower tribes of the animal kingdom bears some analogy to that of vegetables; and as the vital principle in the smallest branch or portion of a willow-tree is easily continued and increased though separated from the parent stem, so in many zoophytical animals a bud, branch, or other section, removed from the full-grown individual, suffers no injury from such partition, but, on the contrary, acquires almost immediately a complete and independent power of existence within itself, and is ere long capable of exercising or enduring a like division in favour of posterity. Animals as well as plants are liable to be affected by the revolutions of the seasons; for the period of flowering in the one class is answered by the season of love in the other, and the fall of the leaf is only analogous to the periodical renewal of the feathers of birds and the hair of quadrupeds. The platanus quits and renews its superficial bark, while serpents and cray-fish cast off and reproduce their scaly and crustaceous covering. To be produced and nourished, to increase, to engender, and to die, are characters common to every class of organized existence; but animals properly so called are alone endowed with instinct and voluntary motion,—they alone possess nerves, muscles, digestive organs, and blood, with the faculties of perception, &c. consequent on these attributes.

The preceding observations will serve to illustrate the principal relations and analogies which exist between animal and vegetable life. But there are other characters proper to animals, the whole of which, however, are not universally bestowed on that class, of which it will now be proper to say a few words. The substance of which even the most perfect animal is composed may be resolved into four *tissues*,—the *cellular*, the *muscular*, the *fibrous*, and the *medullary*.

The cellular tissue is the most extensively bestowed, and forms, according to an expression of the French physiologists, the *canvass* of all the organs, and of every animal. It is even common to vegetables, and serves at once to compose, to unite, and to separate the organs. Formed of laminæ or plates interlacing each other in every direction, and perforated by small cavities which have intimate communication, it also sometimes presents itself under the form of membranes, which, when they assume a tunnelled or cylindrical shape, are denominated vessels. It is in this tissue that the gelatine accumulates for the formation of the cartilages, and the calcareous salts for that of the bones. It is amongst its meshes that the fat is amassed, the small vessels distributed, and warmth developed. It forms the basis of the organs.

The muscular tissue is composed of fibrin, and its chief property is that of contraction. It forms what are called the fleshy parts of bodies. Bundles of this tissue crossing each other compose the heart, and, under another aspect, form the stomach and intestines. It is the agent of movement.

The medullary or nervous substance is composed of a soft albuminous pulp, and is protected by powerful membranes. It enjoys the admirable faculties of perceiving, comparing, judging, remembering, and willing; it gives to the senses their special properties, to the muscles their moving force, and is the seat of that mysterious union between mind and body through which the intellectual faculties result or become manifested, and the exact nature of which the most acute of metaphysical inquirers, and the most accurate and thoughtful observers of nature, have as yet sought in vain to illustrate. Sensation is the attribute of the nerves.

The fibrous tissue, the most resistant and unfeeling of all, fastens the bones to each other, and connects the bones and the muscles. It forms the ligaments, the tendons, many vessels, and some resisting membranes employed for the protection of the more important organs. In composition it approaches the cellular tissue, but its properties are dissimilar. Its character is resistance.

Each of these tissues is destined to the performance of a special purpose: The cellular organizes, the muscular moves, the nervous perceives, the fibrous attaches and resists; but one and all are under the influence of that nourishing fluid, so different in various animals, known by the name of blood. This fluid is red, circulating, of a high temperature, in animals of the superior classes—that is, the mammalia and birds; less red, colder, and not so charged with oxygen, in fishes and reptiles; colourless, but still circulating, in the mollusca; without either colour or movement in insects; scarcely perceptible in certain worms; and apparently wanting in zoophytes. It is this fluid which animates all the organs, and presides over

every function. Nutrition exhausts its principles, digestion repairs them, respiration elaborates and renders it perfect, and the action of the heart gives it circulation.

All these elements united and variously combined compose the different organs of animated beings, the harmonious action of which organs forms the essence of our wellbeing, physically considered, in the present stage of our existence. The human race possesses the attributes of animal life in common with the brute creation; but we must ever bear about with us a firm conviction that these are "the accidents, not the essentials of our nature;"[1] and that however proper it may be to mention them as the technical statements of physiology, yet that they are totally inadequate to the description of a being who bears about with him the germ of immortal life, and knows that he was created "but a little lower than the angels." "Those persons," says Buffon, "who see, hear, or smell imperfectly, are of no less intellectual capacity than others; an evident proof that in man there is something more than an internal sense. This is the soul of man, which is an independent and superior sense, a lofty and spiritual existence, entirely different in its essence and action from the nature of the external senses."

It is easy to perceive that one set of organs may be so related to another as constantly to require its co-existence. Thus, circumscribed respiratory organs are always accompanied by a heart, which causes the blood to flow through them; and a brain is never found without nerves and muscles, which serve it as faithful ministers and attendants. The brain receives impressions, and is enabled to judge of them through the medium of nervous sensations: this is the first mode of the functions of relation. But the order is inverse so far as relates to the phenomena of the will as connected with the exercise of the voice and the organs of movement. The brain wills or commands, the nerves transmit the order, and the muscles execute it.

There are other co-existences in the animal economy as apparent as those above alluded to, the motives of which are not, however, so easily comprehended. We are still ignorant why the viscus called the liver should always exist where there is a heart; and why all orthopterous insects should have the forehead furnished with a broad plate.

It will readily be conceived that the diversified circumstances of life in the various tribes of animals necessitate an infinite variety of phenomena in their functions and faculties. An animal which respires, and has its dwelling in the waters, can neither feel nor move after the manner of one which breathes in the pure air; and wherever there are branchiæ or gills instead of lungs, we are sure also to find oviparous generation, an incomplete circulation, an absence of voice, and imperfect organs of hearing and of smell. But the existence of lungs alters the relation of the whole of these functions.

The same principle may be applied to the different kinds of aliment. A carnivorous animal is endowed with force and courage: it has a strait stomach, short intestines, and a lank or somewhat slender form. Herbivorous animals, on the contrary, are usually mild and timid, dull in action, of a sluggish nature, and unapt to self-defence: their intestines are spacious, and their external forms more or less massive. "The disposition of the alimentary canal determines, in a manner perfectly absolute, the kind of food by which the animal is nourished; but if the animal did not possess, in its senses and organs of motion, the means of distinguishing the kinds of aliment suited to its nature, it is obvious that it could not exist. An animal, therefore, which can only digest flesh, must, to preserve its species, have the power of discovering its prey, of pursuing it, of seizing it, of overcoming it, and of tearing it in pieces. It is necessary then that this animal should have a penetrating eye, a quick smell, a swift motion, address and strength in the jaws and talons. Agreeably to this necessity, a sharp tooth, fitted for cutting flesh, is never co-existent in the same species with a hoof covered with horn, which can only support the animal, but with which it cannot grasp any thing: hence the law according to which all hoofed animals are herbivorous, and also those still more detailed laws, which are but corollaries of the first, that hoofs indicate molar teeth with flat crowns, a very long alimentary canal, a capacious or multiplied stomach, and several other relations of the same kind."[2] In short, such harmony exists between the different organs, according to the leading forms after which they are modelled, that an experienced anatomist, from an inspection of a very limited portion of a body, can form an accurate opinion regarding the entire characters of an animal. It is thus that Cuvier, combining profound knowledge of detail with a commanding power of generalization, has, as it were, called back into existence those long-extinguished races whose scattered and imperfect remains attest the wonderful revolutions to which our planet has of old been subjected.

The aid which natural history has derived from the sister sciences of anatomy and physiology, is in nothing more apparent than in the improved systems of modern classification. It was formerly the practice to adopt, as the basis of arrangement, the modifications of some single organ, chosen arbitrarily and at hazard. Of course it did not follow that all the other organs would resemble each other in all the animals in which the likeness of this one organ might be preserved. Nothing, therefore, could be affirmed respecting the other organs belonging to the whole of a class or genus of animals, which we should have attempted to distinguish by characters taken from this unimportant organ. "Suppose, for example," says Cuvier, "that we had made three divisions of animals, the aerial, terrestrial, and aquatic, as they were anciently classed; there would be included in the first class, besides what are commonly called birds, some mammiferous animals, such as bats—some reptiles, as the dragon—some fishes, as the flying fish—and an infinite multitude of insects. Similar difficulties would occur, in a greater or less degree, in the other two classes." "This example is well calculated to show how important it is that the characters of our divisions should be well chosen; for, though in the formation of methods and systems of natural history, errors so flagrant as the above are not now committed, several naturalists, even in modern times, have adopted divisions which, in the detail, tend to similar results."[3]

It is both interesting and important to trace the different systems of organs in the animal kingdom, from their first feeble rudiments, through a gradual and long-continued chain of increasing manifestation, to their complete development in some particular class or order, in which the perfect exercise of a special function is indispensable to its wellbeing. It is in accordance with such development that the improved classifications of recent times have been established; and it is now admitted as an axiom, that a natural and philosophical arrangement of animals can have no other foundation than a knowledge more or less perfect of anatomical structure. It does not follow from this that every naturalist must be a profound

[1] Grinfield's *Letters to Laurence*. [2] *Lectures on Comparative Anatomy*, vol. i. p. 56. [3] *Loc. cit.* p. 62.

anatomist; for such is the multiplicity of details connected with the history of the haunts and habits of species, and with the discrimination and description of their external characters, which in truth form the proper object of the zoological inquirer, that a much longer period than that allotted to the life of man would be required likewise to ascertain the distinctions of internal structure, were it necessary to apply anatomical science to all the minor details, or even to the less important divisions, of natural history. But the beauty and excellence of the anatomical system consists in the admirable co-ordination of characters which it exhibits, and through which, with rare exceptions, we are able to arrange the subjects of investigation in a natural manner, even according to their external aspect, as soon as we have established certain great leading principles of classification drawn from the facts of anatomical science. The more essential and important characters even of internal structure are manifested externally by the influence which they exert over more obvious though less dominating attributes; and thus, even in the absence of a positive and direct knowledge of general laws, these are indicated with wonderful certainty, though somewhat empirically, by means of superficial observation. It is thus that, through the combined efforts of the naturalist and anatomist, the convenience and facility of application which characterize artificial systems, and constitute indeed their sole value, may be combined with that philosophical accuracy and consonance with the march of nature which results from deeper and more substantial views.

The object of every good method, according to Cuvier, is to reduce a science to its simplest terms, by reducing the propositions it comprehends to the greatest degree of generality of which they are susceptible. A good system must therefore be such as will enable us to assign to each class, and to each of its subdivisions, some qualities common to the greater part of the organs. This object is to be attained by two different means, which may serve to prove or verify one another. "The first, and that to which all men will naturally have recourse, is to proceed from the observation of species to uniting them in genera, and to collecting them into a superior order, according as we find ourselves conducted to that classification by a view of the whole of their attributes. The second, and that which the greater part of modern naturalists have employed, is to fix beforehand upon certain bases of division agreeably to which beings, when observed, are arranged in their proper places. The first method cannot mislead us, but it is applicable only to those beings of which we have a perfect knowledge; the second is more generally practised, but it is subject to error. When the bases that have been adopted remain consistent with the combinations which observation discovers, and when the same foundations are again pointed out by the results deduced from observation, the two means are then in unison, and we may be certain that the method is good."

The true distinction between the value of an artificial and of a natural method in zoology consists in this, that the former teaches us little more than the name of an animal, whereas, in relation to the other, we have no sooner ascertained the name of a species, o. its position in the system, than we become at the same time acquainted with numerous facts in its character and history, which we never could have discovered, except by actual observation, had it formed part of those miscellaneous and falsely connected groups which so often constitute the divisions of an artificial system. A natural arrangement is also of great advantage in facilitating general views, by rendering a single animal a type or representative of many, as containing in itself the essential characters of a numerous tribe; and thus the whole animal kingdom may be represented by a few hundred species. By a too strict adherence, however, to the natural method, we are apt to lose the advantage of precision in individual definitions, and, in the case of the numerous transitions, find ourselves unable to fix any limits, if these have not been already established by nature. To discover a medium between these two methods, so as to unite the advantages of each, is now more than ever desirable in the formation of systems.[1] He indeed who flatters himself with the idea that the families, tribes, genera, and sections, which he has laid down on paper, are so many natural divisions, can only be compared to the person who, because he may find the meridians and other circles of an armillary sphere convenient for the division of the heavens, should therefore imagine that they must exist in nature. "In one and the other case," Mr Macleay observes, "artificial modes of distribution are resorted to, which, however ingenious in themselves, are but sad proofs of the limited state of our faculties, when we consider, that without such instruments the vastness and sublimity of the creation cannot be comprehended." (*Horæ Entom.*) There is in fact no such thing as classification in nature. In the animal as well as in the vegetable kingdom certain species are grouped together by such analogies of form and structure, as to render their mutual resemblances apparent even to an ordinary observer. To these groups the name of natural families may, without impropriety, be applied; but that no general system of arrangement exists in nature, by which the various genera may be made to follow each other, like the links of a linear chain, is evident from the discordant, ever-varying, and frequently arbitrary methods employed even by the most accomplished naturalists of the day. We must probably rest satisfied with such a system as presents the objects of natural history in conveniently arranged groups, the component parts of each of which bear a considerable resemblance to each other, without seeking after what is unattainable, namely, the establishment among these groups of a perfectly natural and well-graduated sequence. "When there are," says Mr Vigors, "no absolute divisions except species in nature—and this, from every observation I have been enabled to make, I firmly believe to be the case—every division which we are forced to institute in our arrangements for the convenience of illustration, and indeed for the purpose of mutual communication with those who are engaged in similar researches with ourselves, must be to a certain extent arbitrary and artificial; and every inquirer into nature may cause the line of demarcation that separates his conterminous groups to infringe more or less on the limits of either, according to his peculiar mode of viewing his subject."[2]

No satisfactory argument can be adduced to prove, as some have imagined, that the specific differences of animals have resulted from the lapse of time, and the effects of climate, or other secondary causes. The variation of specific character, though sometimes remarkable, is restricted; and Cuvier has shown, from a minute examination and comparison of mummies of the ancient Egyptian Ibis with individuals of the modern race, that in regard to that species no perceptible change has taken place during the last three or four thousand years. The original creation of distinct and predetermined species is the rational and well-founded belief of all who have studied the

[1] See Carus's *Introduction to Comp. Anat.*, translated by Gore.

[2] *Linnæan Transactions*, vol. xiv. p. 512.

subject with attention, unbiassed by any prejudice in favour of imaginative views, which have no foundation in the facts of nature. " It is certain by revelation," says Buffon, " that all creatures have equally participated in the favours of creation; that the first two of each species were formed by the hands of the Creator; and we ought to believe that they were then nearly such as they appear at present in their descendants. We must also consider, that although nature proceeds by gradual, and frequently by imperceptible degrees, the intervals are not always the same. The more exalted the species, the fewer they are in number; and the shades by which they are separated are more conspicuous. The smaller species, on the contrary, are very numerous, and have more affinity to each other, so that we are the more tempted to confound them together in the same family. But we should not forget that these families are our own works; that we have made them for the ease of our memories; and that if we cannot comprehend the real relations of all beings, it is ourselves, not nature, that are in fault; for she in truth knows not our pretended families, and recognises individuals alone."

Omnipotence, the first, the greatest, and indeed the only truly creative power, formed the species of animals; and the influence of man and of physical agents has produced the varieties. But it is only superficial characters which either the one or the other of these ulterior causes has the power of modifying. The basis of organization, or real specific mould, remains unalterable, though a thousand circumstances constantly tend to produce variations in the external forms. Of these circumstances the most powerful is no doubt climate; under which name it is necessary to comprehend the differences of local situation and temperature, the nature of the soil and its productions. It is climate, in the first place, which chiefly determines the geographical position of animals, and thus commences the action of the modifying powers. The nature of their food is also highly influential; and as it depends so immediately on the qualities of temperature and soil, the climate is still the modifying cause. If the same animals usually accompany the same vegetables, it is because the constitution of both demands similar influences, and because through each other they are both dependent upon the same support. Certain animals are leagued with certain plants, and these again with certain soils and climates; and a careful observance of these mutual dependencies exhibits one of the finest and most beautiful harmonies of nature. This, however, is not the place in which to discuss the intricate and important subject of the geographical distribution of animals.

Certain original forms have been continued since the creation of organized beings, and all the *individuals* which represent or belong to one of these forms constitute what is called a *species*. The slighter differences which occasionally prevail among the individuals themselves, independent of the customary distinctions of age and sex, are called *varieties*. Such varieties are seldom permanent, and are usually lost by the progeny re-assuming the ordinary and characteristic form or colour, except in some remarkable instances, such as the horse, dog, and other long-domesticated species, of which man has so thoroughly altered the original condition, as to have impressed them with a second and more pliant nature. An individual, according to Buffon, is a separate detached being, and has nothing in common with other beings, excepting that it resembles, or rather differs from them. All similar individuals which exist on the earth are considered as composing the species of those individuals. Yet it is neither the number nor collection of similar individuals which constitutes them; for a being which existed for ever would not be a species. " Species then is an abstract and general term, the meaning of which can only be determined by considering nature in the succession of time, and in the constant destruction and renewal of beings;" and it is by comparing the present state of nature with the past, and actual individuals with their predecessors in kind, that we come to attain a clear idea of what is called species; for a comparison of the number or resemblance of individuals is only an accessory idea, and frequently independent of the first. The ass resembles the horse more than the barbet the greyhound; yet the latter are but one species, since they produce a fertile progeny; but the horse and the ass are certainly of different species, " since they produce together vicious and unfertile young."

It is indeed difficult to define the term *species*, otherwise than as an assemblage of individuals descended from common parents, which bear as great a resemblance to them as they do to each other. Species then are distinguished by fixed forms, which, though to a certain extent alterable, and for a limited time, by external or accidental causes, are yet handed down unimpaired from generation to generation; and although certain species seem to have disappeared entirely from the earth, in consequence of the great natural catastrophes which have taken place in ancient times, and the local distribution of many still existing races has been modified or changed by the influence of man no less than by the accidents of nature, there is no reason to believe that any one species has sprung from the gradual alteration of another, or that the circumstances under which an individual may have been at first casually placed were sufficient to develope both form and function, without an impress from a higher and more powerful hand, by which it was fitted to perform its part (pre-ordained) in the great theatre of the world.

Animals which by their union produce *fertile* individuals, are generally reputed of the same species. This law of nature, as it was formerly called, having been found to admit of certain though rare exceptions, is not now so broadly insisted on as a test of specific identity as it was in preceding times. But it appears, from the result of numerous experiments, that the generality of animals produced from a cross between even the most nearly allied species, are either altogether incapable of reproduction, or fertile in so imperfect a degree, that their descendants speedily become entirely sterile. It has been said that birds alone were unsubjected to this rule, and that hence has arisen the wonderful variety which that beautiful class exhibits. There is no doubt of the occasional fertility of their hybrids, as in the case of those mule birds produced between the goldfinch and canary; but as it has not been proved that such unions of distinct kinds ever take place when uncontrolled by the depraving influence of domestication, there is no reason to attribute the origin of any of those species or varieties which are known to exist in a wild state to any such improbable alliance.

It is known that a productive union may take place between animals of a different species, provided such species belong to what naturalists call the same natural family. Thus the ass and the mare, or the horse and the female ass, produce the well-known animals called mules: the zebra also produces both with the horse and the ass; but in order to deceive the female zebra, it is said to be necessary to paint the hides of the former with those bizarre colours which adorn her accustomed mate.[1] It is probable,

[1] *Dict. Class. d'Hist. Nat.* tome i. p. 48.

however, that all these unions are so far forced and unnatural, that they never take place except through the influence of man, when domestication, and the numerous changes consequent upon it, have altered or impaired their natural instincts; for it has been observed that, however education may perfect certain special qualities, which man has the art to render subservient to his own convenience, yet a more extended view of the effects of domestication will convince us, that it is almost always to the disadvantage of their natural capacities that the brute creation are made to borrow the mask of human intelligence.

Buffon appears to have adopted from Ray a rule which many now regard as inaccurate and artificial, but which he made use of to determine the identity of animal species, viz. "any two animals that can procreate together, and whose issue can also procreate, are specifically the same." In this, however, it has been observed that he contradicts himself by afterwards admitting that the sheep and goat are of different species, at the same time that he asserts that the he-goat and the ewe produce a mixed breed which continue fertile for ever. Dr John Hunter (a great authority) was also of opinion that the true distinction between different species of animals must ultimately be gathered from their incapacity of propagating with each other an offspring capable of again continuing the kind. Thus the horse and ass beget a mule capable of copulation, but incapable of begetting or producing offspring. The accident of a mule breeding, according to the same authority, even if it were proved, would only show that as many perfect animals of true species and distinct sexes are incapable of breeding at all,—(thus showing that nature, even in her greatest perfection, sometimes deviates from general principles),—so it may occasionally happen that a mule shall breed from the circumstance of its being "a monster respecting mules."

The doctrine of equivocal generation has received no support from any recent investigations. All that is *known* decidedly leads to the opposite conclusion; and if certain mysterious or unaccountable phenomena have perplexed the physiologist, the only legitimate deduction is, that he has met with something which he cannot comprehend; for those aberrations (if such they really are) from the usual laws of nature are not so much exceptions to the general rule, as additional instances of effects in nature, the regulating causes of which we are as yet incapable of demonstrating. The rules of philosophizing lead us to reject the admission of more causes than are sufficient for the explanation of phenomena; and if, for example, mites, and "such small deer," derived their origin solely from the caseous and other substances in which they are generally found, the sexual distinctions which prevail among other animals would in them be unnecessary, and would not therefore be observable. But we know that distinct sexes do exist among these minute creatures—that they propagate their kinds after the accustomed mode—and we hence fairly infer that fortuitous generation does not take place among them. May we not therefore conclude that the origin of those first observed is similar to that of the thousands which we afterwards *see produced* according to the usual process? Nature does nothing in vain, and it is not consonant with her usual practice to suppose that she would authorize two distinct modes of creation in the same animal, where one of these is evidently perfect and self-sufficing. It may therefore be laid down as a general rule, that all living beings proceed from others of a similar nature, either by generation, offset, or some other means; and that, in all instances of apparently spontaneous production, there has existed some minute or imperceptible germs, which deceive us by their sudden development when placed under favourable circumstances. "In fact," says Cuvier, "however feeble and minute the parts of an embryo or the seed of a plant may be at the moment we are first capable of perceiving them, they then enjoy a real life, and possess the germ of all the phenomena which that life may afterwards develope. These observations, extended to all the classes of living bodies, lead to this general fact, that there are none of those bodies which have not heretofore formed part of a body similar to itself, from which it has been detached." "It is from them (their parents) they have received the vital impulse; and hence it is evident that, in the actual state of things, life proceeds only from life, and that there exists no other, except that which has been transmitted from one living body to another by an uninterrupted succession." "Origin by generation, growth by nutrition, termination by death, are the general and common characteristics of all organized beings.[1]"

At the same time it must be admitted, that the origin of many infusory and intestinal animals is sufficiently obscure. Of the latter class, one of the most extraordinary is a monstrous worm, as it may be called, which at distant intervals, and in parts of the world far removed from each other, has been found to inhabit the liver of the human race. The means by which it is bred, or the circumstances favourable to its production, are quite unknown; and some of the most philosophical inquirers of the present day have been unable to account for its origin, otherwise than by supposing that the viscus called the liver becomes, under certain circumstances, endowed with the power of actually secreting a substance capable of assuming and presenting the phenomena of distinct animal existence, and which, prior to the period of its being observed, had in fact become a specific animal;—at least its existence, unlike that of mites, flies, &c. which so often misled the ancient naturalists (though "*in* limo non *ex* limo" is Ovid's more accurate expression), cannot be accounted for in any other way. "There are," Mr W. S. Macleay observes, in his excellent and ingenious *Horæ Entomologicæ*, "many circumstances which might be adduced to support the belief that, whether from disease or other causes, there are periods when other parts of a body besides the ovarium may produce living germs, and demonstrate thus the polype nature of the cellular substance."

A polypus has been sometimes described as an animalized tube, capable of digestion, and possessed of a certain power of motion and reproduction; and these few words may be said to contain almost all that we know of its essential nature and attributes. As we advance in the scale of creation, we find a more complicated system of organs, with more varied powers of action, and a higher development of those accommodating instincts which, though circumscribed within certain impassable boundaries, yet seem at times to form such an approach to reason, as to connect the unvarying mechanical actions of the most simple zoophytical tribes with the conscious self-regulating power which has its final and most perfect development in the human race. The excellence of man, however, physically considered, consists more in the balance of various powers than in any one bodily superiority; for there is in fact no single sense in which he is not excelled by one or other of the brute creation. Materialists, who regard the intellectual superiority of man as the result of his physical structure, must also, for the sake of consistency, maintain his excellence as a machine to be infinitely be-

[1] *Lectures on Comp. Anat.* vol. i.

fore that of every other animal. But as his indubitable superiority depends on something totally immaterial, which "throws him out of the group of animals, and makes him an insulated being," there is the less necessity for either naturalists or metaphysical inquirers endeavouring to demonstrate the superexcellence of his physical condition. Man is in all cases "wonderfully," and in many cases "fearfully made;" but in the powers of sight, touch, hearing, and smell, he is greatly surpassed by many animals; and even in the sense of taste, in which his practice is more varied and extensive, he is at least equalled by the great majority. It is indeed somewhat remarkable that the last-named sense, the only one in regard to which the human race can lay claim to the possession of equal excellence with the brutes that perish, should be the grossest and least intellectual of the whole.

Although it is by no means strictly true that the brain, considered in relation to the size of the body, decreases as we descend from man to the lower tribes, because in many small birds, such as sparrows and finches, the brain is relatively much larger than in the human race, yet, exclusive of some such exceptions, it may be asserted that that important organ becomes less as we descend from mammiferous animals and birds, to reptiles, fishes, and other lower forms. Yet no very accurate conclusion can be deduced regarding the degrees of intelligence in different animals, from the proportion which the quantity of brain bears to the mass of the whole body, particularly when we come to compare animals of the same class with each other. It is in fact by no means easy to ascertain with accuracy what that proportion really is, because the weight of the brain is supposed to remain the same, while that of the animal varies according to its temporary condition. In this way only can we account for the contradictions which appear in the tabular views which have been given of these proportions by physiologists. Upon the whole, the smaller animals pertaining to the higher classes appear to have proportionally the largest brain, though man is in this respect seldom surpassed. The proportional weight of the brain to the body of man varies from 1-22d to 1-35th part, that of the gibbon or long-armed ape is as 1 to 40, that of the young malbrouk (*Simia Faunus*) as 1 to 24, that of the fox as 1 to 205, that of the beaver as 1 to 290, that of the field-mouse as 1 to 31, that of the elephant as 1 to 500, that of the horse as 1 to 400, that of the eagle as 1 to 160, that of the sparrow as 1 to 25, that of the canary-bird as 1 to 14, that of the cock as 1 to 25, that of the goose as 1 to 360, that of the land-tortoise as 1 to 2240, and that of the sea-tortoise as 1 to 5688.

Soemmering, Ebell, Vicq-d'Azir, Gall, and Tiedemann, supposed that every thing depended on the *volume* of the brain. But as Buffon and Daubenton had proved that the Sapajous have the brain proportionally larger than man, without surpassing their congeners in intelligence, it has been maintained by others that the volume alone was not a condition of superiority. Now the Sapajous in question have no *convolutions* to the brain, so that the surface of that organ is represented by that of the interior of the cranium, and exceeds it in other cases in proportion as its folds are numerous and profound; and as there appears to be a constant relation among mammiferous animals between the diminution of the cerebral surfaces and their intellectual degradation, whilst no such relation can be traced between the degrees of degradation and the variations of the brain in respect to size, it has hence been inferred by some that the extent of surface, and not the volume of the brain, ought to be regarded as co-relative with the intellectual faculties.[1]

In proportion, however, as the superior portion called the brain decreases in size, the medullary matter appears to collect in other parts of the body, or in the cords which emanate from the brain; so that many animals with much smaller brains have nerves more voluminous in proportion to their bodies than those of man. This medullary substance, the medium of sensation, is, in the human race especially, collected into one principal mass as the engine of thought and reflection, the intellectual attributes by which man is characterized; but it becomes dispersed in the inferior animals, or ramified over the whole body in the form of ganglions or nervous chords, without any preponderating superior brain. It is owing to this dispersion of the nervous system into these small separate centres in the polypus and other tribes, that almost every portion of the body, when separated from the rest, is capable of becoming a distinct animal, and of assuming an independent existence. In the lowest tribes of all, in which the nervous system has not yet been demonstrated, it probably consists of molecules of inconceivable minuteness, disseminated through the pulpy or gelatinous masses of which the bodies of many radiated and infusory animals are composed.

Singular effects result from the dispersion of the brain into so many small and separate centres; and this class of phenomena also illustrates the analogy which exists between the lower animals and the vegetable world. Among the superior creatures no reproduction takes place except of the fluids, and of whatever partakes of the nature of the epidermis. Injury is repaired and superficial parts renewed, but nothing resembling regeneration of important organs ever takes place. But it is otherwise with the inferior orders. The tentacula of the polypus and of many molluscous animals, the rays of the star-fish, the external members of the salamander, and the entire head, with the eyes and antennæ of the snail, when cut off, are speedily renewed. There are also animals, such as the planaria, which reproduce by offsets after the manner of plants; and a polypus may be divided into many portions, each of which becomes perfect according to its kind;—thus in a manner realizing what the ancient poets have feigned regarding the hydra of the Lernean marshes.

If the head of a mammiferous quadruped, or of a bird, is cut off, the consequences are of course fatal. But the most dreadful wounds that imagination can figure or cruelty inflict have scarcely any destructive influence on the vital functions of many of the inferior creatures. Riboud stuck different beetles through with pins, and cut and lacerated others in the severest manner, without greatly accelerating death. Leeuwenhoeck had a mite which lived eleven weeks transfixed on a point for microscopical investigation. Vaillant caught a locust at the Cape of Good Hope, and after excavating the intestines, he filled the abdomen with cotton, and stuck a stout pin through the thorax, yet the feet and antennæ were in full play after the lapse of five months. In the beginning of November, Redi opened the scull of a land-tortoise, and removed the entire brain. A fleshy integument was observed to form over the opening, and the animal lived for six months. Spallanzani cut the heart out of three newts, which immediately took to flight, leapt, swam, and executed their usual functions for 48 hours. M. Virey informs us, "Nous avons vu une salamandre vivant depuis deux mois, quoique décapitée au moyen d'une ligature serrée du cou." A decapitated beetle will advance over a table, and recognise

[1] See Desmoulins, *Rech. Anat. et Phys.*, and the *Journ. Compt. du Dict. des Sciences Med.* Septembre 1822.

a precipice on approaching the edge. Redi cut off the head of a tortoise, which survived 18 days. Colonel Pringle decapitated several libellulæ or dragonflies, one of which afterwards lived for four months, and another for six; and, which seems rather odd, he could never keep alive those with their heads on above a few days.[1]

Some curious particulars connected with the great tenacity of life in the lower animals are mentioned by Mr Fothergill.[2] A friend being employed one day in the pursuit of insects, caught a large yellow dragonfly (*Libellula varia*), and had actually fastened it down in his insect box, by thrusting a pin through the thorax, before he perceived that the voracious creature held a small fly, which still struggled for liberty, in its jaws. The dragonfly continued devouring its victim with great deliberation, and without expressing either pain or constraint, and seemed totally unconscious of being pinned down to the cork, till its prey was devoured, after which it made several desperate efforts to regain its liberty. A common flesh-fly was then presented to it, when it immediately became quiet, and ate the fly with greediness: when its repast was over it renewed its efforts to escape. This fact being mentioned to Mr Haworth, the well-known English entomologist, he confirmed the truth of the remarkable insensibility to pain manifested by insects, by narrating an additional circumstance. Being in a garden with a friend who firmly believed in the delicate susceptibility of these creatures, he struck down a large dragonfly, and in so doing unfortunately severed its long abdomen from the rest of the body. He caught a small fly, which he presented to the mutilated insect, by which it was instantly seized and devoured; and a second was treated in the same manner. Mr Haworth then contrived to form a false abdomen, by means of a slender portion of a geranium; and after this operation was performed the dragonfly devoured another small insect as greedily as before. When set at liberty, it flew away with as much apparent glee as if it had received no injury. It is a fact well known to practical entomologists, that large moths found asleep during the daytime may be pinned to the trunks of trees without their appearing to suffer such a degree of pain as even to awake them. It is only on the approach of the evening twilight that they seek to free themselves from what they must no doubt regard as an inconvenient situation.

The cruelty of zoological, especially of entomological pursuits, has too often been stated as an objection to the practical parts of the study of natural history. When a noble aristocrat (who thinks it sport to shoot a shepherd's dog) slaughters 100 brace of grouse in a single day, we hear nothing of such an objection, possibly because the flavour of moor-game is very exquisite; and the reason of defence is good. But the tastes of men differ, and fortunately, as all have not the means of an equal gratification from the same source. "Cruelty," say Messrs Kirby and Spence, "is an unnecessary infliction of suffering, when a person is fond of torturing or destroying God's creatures from mere wantonness, with no useful end in view; or when, if their death be useful and lawful, he has recourse to circuitous modes of killing them, where direct ones would answer equally well. This is cruelty, and this with you we abominate; but not the infliction of death when a just occasion calls for it. They who see no cruelty in the sports of the field, as they are called, can never, of course, consistently allege such a charge against the entomologist; the tortures of wounded birds, of fish that swallow the hook and break the line, or of the hunted hare, being beyond comparison greater than those of insects destroyed in the usual mode. With respect to utility, the sportsman, who, though he adds indeed to the general stock of food, makes amusement his primary object, must surely yield the palm to the entomologist, who adds to the general stock of mental food, often supplies hints for useful improvement in the arts and sciences, and the objects of whose pursuit, unlike that of the former, are preserved, and may be applied to use for many years. But in the view of those even who think inhumanity chargeable upon the sportsman, it will be easy to place considerations which may secure the entomologist from such reproof. It is well known, that in proportion as we descend in the scale of being, the sensibility of the objects that constitute it diminishes. The tortoise walks about after losing its head; and the polypus, so far from being injured by the application of the knife, thereby acquires an extension of existence. Insensibility almost equally great may be found in the insect world. This, indeed, might be inferred *a priori*, since providence seems to have been more prodigal of insect life than of that of any other order of creatures, animalcula perhaps alone excepted. No part of the creation is exposed to the attack of so many enemies, or subject to so many disasters; so that the few individuals of each kind which enrich the valued museum of the entomologist, many of which are dearer to him than gold or gems, are snatched from the ravenous maw of some bird or fish, or rapacious insect, would have been driven by the winds into the waters and drowned, or trodden under foot by man or beasts; for it is not easy in some parts of the year to set foot to the ground without crushing these minute animals; and thus also, instead of being buried in oblivion, they have a kind of immortality conferred upon them. Can it be believed that the beneficent Creator, whose tender mercies are over all his works, would expose these helpless beings to such innumerable enemies and injuries, were they endued with the same sense of pain and irritability of nerve with the higher orders of animals?"[3] Instead, therefore, of believing, and being grieved by the belief, that the insect we tread upon,

> In corporal sufferance finds a pang as great
> As when a giant dies,

the very converse is nearer the truth. "Had a giant lost an arm or a leg," continue the authors just quoted, "or were a sword or spear run through his body, he would feel no great inclination for running about, dancing, or eating. Yet a tipula will leave half its legs in the hands of an unlucky boy who has endeavoured to catch it, and will fly here and there with as much agility and unconcern as if nothing had happened to it; and an insect impaled upon a pin will often devour its prey with as much avidity as when at liberty. Were a giant eviscerated, his body divided in the middle, or his head cut off, it would be all over with him; he would move no more; he would be dead to the calls of hunger, or the emotions of fear, anger, or love. Not so our insects: I have seen the common cockchafer walk about with apparent indifference after some bird had nearly emptied its body of its viscera; a humble bee will eat honey with greediness though deprived of its abdomen; and I myself lately saw an ant, which had been brought out of the nest by its comrades, walk when deprived of its head. The head of a wasp will attempt to bite after it is separated from the rest of the body; and the abdomen, under similar circumstances, if the finger be moved to it, will attempt to sting." Query, which part felt conscious of being the original wasp?

That the acuteness of bodily suffering, even among the

[1] See the observations prefixed to the translation of *Spallanzani's Tracts*, by John Graham Dalyell, Esq.

[2] *Essay on Natural History.*

[3] Introduction to *Entomology*, vol. i. p. 56.

higher classes of the brute creation, is in some manner providentially subdued, and rendered so much less acute as not to be a fit subject of comparison with the suffering of the human race, is indeed evident from various phenomena, whatever the cause may be. The writer of this article has seen a turtle-dove (*Columba risoria*) which was so severely lacerated by a cat, that the contents of its stomach were torn out. The painfully excited sympathy of those who had long cherished the gentle creature was, however, in a great measure allayed by seeing the bird immediately afterwards proceed to pick up the fresh grains of barley which (till the aid of the surgeon was called in) continued to fall from its wounded paunch.

Considerations of the nature glanced at in the preceding paragraphs can never, of course, be so misconstrued as to afford any palliation to wanton or inconsiderate cruelty to the brute creation. The judges of the Areopagus who condemned to death the child whose amusement it had been to pluck out the eyes of quails, were regulated in their determination by the motives imputed to the young criminal, and which they deemed expressive of so cruel and pernicious a character, that in after-times he would assuredly offend the state. "Nec mihi videntur Areopagitæ," says Quintilian, "cum damnaverunt puerum coturnicum oculos eruentem, aliud judicasse, quam id signum esse perniciosissimæ mentis, multisque malo futuræ, si adolevisset."[1] But had some great oculist, intent on the structure and physiology of the human eye, and engaged in a difficult course of experimental observation, by means of which the "dim suffusion" which often veils the orbs of his fellow-men might be obviated or decreased, found himself under the necessity of having recourse to a somewhat similar operation, the case would have assumed another character, and the most sentimental philanthropist must have applauded the practice of the philosopher. So it is in a great measure with the pursuits of the naturalist. If the wonderful structure of the lower orders of creation cannot be studied or understood, or their infinitely varied forms held in remembrance, without hastening by a few days or hours the termination of that brief career which in truth scarcely ever meets with a strictly natural end, then is the student of nature, following out the principles of an elevating and intellectual pursuit, as well entitled to command a portion of animal life as he who, to pamper the refined grossness of a sensual appetite, bleeds his turkeys to death by cutting the roots of their tongues, boils crabs and lobsters alive, and swallows unsuspecting oysters by the score.

The more perfect the nervous system, the greater is the degree of intelligence. Indeed, were it not that no trace of that system has yet been discovered in many zoophytes, we might almost assert that the presence of nerves constitutes animal life, and that their absence in organized matter reduces it to the vegetable state. The greater the extent of brain in proportion to the size of the body, the greater in general the degree of sensibility. A French anatomist, in dissecting a horse of which he had admired the noble qualities, exclaimed, "J'ai long temps douté si nous avions le droit de monter sur ton dos ; mais en voyant la petite capacité de ton cerveau, je n'en doute plus maintenant ; tu n'est qu'une bête." The most perfect animals are such as are provided with a head which serves as the centre of their sentiments and sensations, and with a mouth for the reception of their nourishment. Their forms are symmetrical, or composed of two equal parts ; they change their place by a voluntary act ; their sexes are distinct, and separately incapable of continuing the species ; they are provided with five senses, and endowed with the perception of pleasure and of pain. The inferior tribes, on the contrary, which present so many analogies to the vegetable kingdom, have no distinct head, or single organ of life ; they are not symmetrical or composed exactly of two equal parts, but rather affect the circular or radiated form ; and for the most part they either remain fixed to the place which gave them birth, or with difficulty change their places of abode. The sexes are frequently united in the same individual, and their senses are limited to such as are necessary to a very confined and almost vegetative existence.

Though no animal has more than five senses, a great many are much more sparingly endowed. The only universal sense seems that of touch. The next to be developed is probably that of taste, then sight, hearing, and, lastly, smell. In the human race the senses are more equally balanced than in the brute creation, among the different tribes of which we find many animals as remarkable for their extreme acuteness in certain senses, as for their obtuseness in respect to others. The sense of smell in the dog, excepting some artificial varieties, such as the greyhound, prevails over every other ; birds of prey are remarkable for their keenness of sight ; the sense of hearing is strong in the hare ; that of touch in the trunk of the elephant ; that of taste in the lord of the creation. It follows as a consequence that the dog is by nature a hunting animal ; that the eagle, upborne upon resplendent wing, describes its magnificent circles in the air, "sagacious of its quarry from afar ;" that the hare couches securely among the long dewy grass, with its head so low that its eyes must be almost useless, but trusting to its quicker ears, which warn it of an approaching foe ; that the elephant examines the exact nature of all objects by touching them with the fleshy finger of its proboscis ; and that Mrs Rundell's work on cookery has run through countless editions. All insects in the perfect state, and the greater proportion of their larvæ, a part only of the molluscous tribes (such as the inhabitants of univalve shells), crustaceous animals, such as crabs and lobsters, and all fishes, reptiles, birds, and quadrupeds, enjoy the sense of sight ; and all these classes (with the exception of insects and many of the mollusca) are also furnished with the organs of hearing. That the latter sense, however, also exists in insects, may be fairly inferred from the frequent and varied sounds which they are capable of producing, although the seat of the faculty has not yet been ascertained. Many zoophytical tribes, which have no special organs of sight, appear to become sensible to the presence and action of light, through a delicate perception of the sense of touch. According to Buffon, the sense which has the strongest affinity to thought is that of touch ; and he regards it as being enjoyed by man in greater perfection than by animals. That which has the strongest affinity to instinct and appetite is smell,—a sense in which man must acknowledge an infinite inferiority. Hence, according to the Frenchman, man has the greatest tendency to knowledge, and the brute to appetite. There is no doubt that in man and the different species of monkeys the sense of touch is highly discriminating ; but it is assuredly a false view of the subject which has led Helvetius and others to attach such an extraordinary degree of importance to the *hand*, as the medium of intellectual superiority in the human race.

Whatever exhibits the phenomena of either animal or

[1] *De Inst. Orat.* lib. v. cap. ix. *de Signis.*

vegetable life, advances towards the perfect development of its parts through the medium of aliment. This name is applied to the numerous and diversified substances which, when introduced into the system of an organized body, have the power of identifying themselves in part with that system, in such a manner as to effect its nourishment, reparation, and increase. "Nourishment," says Bacon, "ought to bee of an inferior nature and more simple substance than the thing nourished. Plants are nourished with the earth and water, living creatures with plants, man with living creatures. There are also certain creatures feeding upon flesh; and man himself takes plants into a part of his nourishment: but man and creatures feeding upon flesh are scarcely nourished with plants alone. Perhaps fruits or graines, baked or boyled, may with long use nourish them, but leaves of plants or herbs will not doe it; as the order of the *Foliatanes* showed by experience living creatures are nourished by the mouth; plants by the root; young ones in the womb by the navill; birds for a while are nourished with the yolke in the egge, whereof some is found in their crops after they are hatched. All nourishment moveth from the centre to the circumference, or from the inward to the outward: yet it is to be noted, that in trees and plants the nourishment passeth rather by the barke and outward parts than by the pith and inward parts; for if the barke be pilled off, though but for a small bredth round, they live no more: and the blood in the veines of living creatures doth no lesse nourish the flesh beneath it than the flesh above it. Vegetables assimilate their nourishment simply without excerning; for gums and teares of trees are rather exuberances than excrements; and knots or knobs are nothing but diseases. But the substance of living creatures is more perceptible of the like; and therefore it is conjoyned with a kinde of disdaine, whereby it rejecteth the bad and assimilateth the good. It is a strange thing of the *stalkes* of fruits, that all the nourishment which produceth sometimes such great fruits should be forced to passe thorow so narrow necks, for the fruit is never joyn'd to the stock without some stalkes. It is to be noted, that the seeds of living creatures will not be fruitful but when they are new; but the seeds of plants will be fruitful a long time after they are gathered; yet the slips or cions of trees will not grow unlesse they be grafted green, neither will the roots keepe long fresh unlesse they be covered with earth."[1]

Nutritive substances of course vary according to the nature of the bodies which consume or absorb them. Plants derive their chief nourishment from air and water, the former of which must contain carbonic acid gas, the latter the dissolved remains of animal or vegetable substances. It is, however, possible to produce vegetable growth from pure water, assisted by warmth and air. Vegetables, again, serve as food to the greater proportion of animals, and these in their turn are devoured by the carnivorous few. It is thus that the productions of nature are connected together in one great circle, and are reciprocally dependent on each other. Without water there could be neither plants nor herbivorous animals, and without herbivorous animals there could be no carnivorous ones; therefore, without water there could be no life. Inorganic matter furnishes the first and most simple materials of existence; organic bodies perish and become decomposed, and thus adding to the mass of inorganic matter which they had for a short period abandoned, they enter again as elements into the composition of other and more complex forms. Indeed, according to Mr W. S. Macleay, organized matter is nothing but a peculiar modification of brute matter acted upon by the vital principle; but this form of expression probably throws no new light upon the subject.

We may here present a remark not unworthy of attention regarding the nature of the flesh in the different classes of the animal kingdom. Considered as a viand, the flesh of animals becomes less substantially nourishing as we descend in the scale. For example, the flesh of a quadruped contains a greater quantity of nourishment in proportion to size and weight than that of a bird, while the latter exceeds in that respect both reptiles and fishes. Hence in catholic countries the latter are justly regarded as *meagre*, and form an exclusive food during the frequent days of abstinence by which it is sought to mortify the flesh. Shell-fish and crustacea, and *a fortiori* the zoophytical tribes, yield a still smaller proportion of nutritious matter. A revolting conclusion has been drawn from this alleged relation between the flesh of a highly organized animal and the power and excellence of its nutritive qualities; viz. that cannibalism, or the habit of anthropophagous nations, opens up to those unnatural tribes a pleasure connected with the indulgence of the sense of taste greatly surpassing what is enjoyed by those who confine their mastication to the brute creation; because, in accordance with the rule supposed, the organic perfection and highly animalized nature of man is productive of a higher degree of nutrition, and of a greater capability of direct assimilation, when the substance of which he is composed is used as food by his fellow-mortals. But the scale of alimentary substances may rather be said to commence with air and water, and to terminate with the herbivorous animals; for the flesh of carnivorous kinds is, with very few exceptions, of a nature inadequate to the healthy sustenance of life. It is of a quality too putrescent, and decomposes with too great rapidity, as if the organization of matter could make no further progress, but passing rapidly from one extreme to another, hastened to throw off even the semblance of life, to assume again the simplest elementary form. "Over-great affinity," says Bacon, "or consubstantiality of the nourishment to the thing nourished, proveth not well; for creatures feeding upon herbs touch no flesh; and of creatures feeding upon flesh few of them eat their owne kinde. As for men which are cannibals, they feed not ordinarily upon men's flesh, but reserve it as a dainty either to serve their revenge upon their enemies, or to satisfie their appetite at some times. So the ground is best sowne with seed growing elsewhere; and men do not use to graft or innoculate upon the same stocke."

Mineral bodies are still more unfit for the purposes of nutrition. They furnish both medicines and poisons in abundance, but never aliments. The difference between these objects may be shortly stated as follows: Aliments are substances alterable by the action of the organs which appropriate them; medicines act on the organs, of which they alter or modify the action; poisons attack and extinguish life itself. But according to the specific nature of different animals, and various other circumstances, the qualities of these agents are convertible, so that aliments become poisonous, and poisons alimentary. Thus opium, which among European nations is a medicine, and too frequently a poison, has become, according to the practice of several eastern nations, an alimentary substance. Aloes, which are simply medicinal for the human race, are a destructive poison to many carnivorous animals. On the other hand, according to Pallas, hedgehogs eat abundantly of cantharides without being in the slightest degree incommoded by them; and bees are known to feed

[1] *History, Naturall and Experimental, of Life and Death.* English translation, 1638.

upon and form their honey from the secretions of many pernicious and even poisonous plants. The caterpillar of a certain sphinx moth is highly delighted with the acrid and venomous fluid of a tithymalis.

The more that animals enjoy the qualities of youth, strength, and activity, the greater is the increase and development of their parts, and the greater the necessity for an abundant supply of food. Of many individuals exposed to an absolute abstinence of many days, the young are always the first to perish. Of this the history of war and shipwreck offers in all ages too many frightful examples. There are several instances on record of an almost total abstinence from food for an extraordinary length of time. Captain Bligh, of the Bounty, sailed nearly 4000 miles in an open boat, with occasionally a single small bird not many ounces in weight for the daily sustenance of 17 people; and it is even alleged, that 14 men and women of the Juno, having suffered shipwreck on the coast of Arracan, lived 23 days without any food. Two people first died of want on the fifth day. In the opinion of Rhedi, animals support want much longer than is generally believed. A civet cat lived 10 days without food, an antelope 20, and a very large wild cat also 20; an eagle survived 28 days, a badger one month, and several dogs 36 days. In the memoirs of the Academy of Sciences there is an account of a bitch, which having been accidentally shut up alone in a country-house, existed for 40 days without any other nourishment than the stuff on the wool of a mattress which she had torn to pieces. A crocodile will live two months without food, a scorpion three, a bear six, a chameleon eight, and a viper ten. Vaillant had a spider that lived nearly a year without food, and was so far from being weakened by abstinence, that it immediately killed another large spider, equally vigorous but not so hungry, which was put in along with it. John Hunter inclosed a toad between two stone flower-pots, and found it as lively as ever after 14 months. Land-tortoises have lived without food for 18 months; and Baker is known to have kept a beetle in a state of total abstinence for three years. It afterwards made its escape.[1] Dr Shaw gives an account of two serpents which lived in a bottle without any food for five years.

The necessity of aliment becomes less vividly felt during sleep, and certain other periods of prolonged repose. There are several animals which hybernate, or go into winter quarters for six months in the year, during which period many of them require no food, but are maintained solely by that excellence of bodily condition which they had acquired during a prior period of activity and good cheer. This leads us naturally to consider what is called the *hybernation* of animals.

Many creatures are so constituted that the activity of their functions is greatly impaired by a comparatively slight reduction of temperature. Naturalists and anatomists have alike sought in vain for either external or internal characters of general application, by which they might distinguish, *a priori*, the species subjected to this strange though well-ordered lethargy. They belong to various genera and tribes, many of which have few characters in common, as will be perceived when we name as well-known instances the dormouse, the hedgehog, and the bat. It influences both warm and cold-blooded animals. The former of these, at certain advanced periods of the autumn, according to the species, seek out places of repose, either in the earth, among old walls, in caverns, trunks of trees, or bushes; which retreats they usually line with dried herbs, grasses, leaves, or moss. The bat chooses caverns, churches, barns, and other situations where the temperature is milder than that of the open air; and, contrary to the usual practice, it suspends itself by the hooked claws of its hinder extremities. It is the practice of other hybernating animals to contract themselves into a ball, in such a manner as to expose the smallest possible surface to the action of the air. When discovered in their retreats they are generally thus rolled up, cold to the touch, their limbs stiffened, their eyes closed, their respiration slow, interrupted, sometimes even imperceptible, and their insensibility so great that they may be removed, rolled about, and otherwise maltreated, without showing any further signs of life.

It has been observed that the temperature of these animals gradually lowers itself as the season declines. Their respiration also becomes slower, their motions less lively, and their appetite diminishes; but sensation and the power of locomotion still continue. This intermediate state between the perfect performance of the vital functions and confirmed torpidity endures for several weeks; the degree of temperature at which different animals become entirely overpowered varying, of course, according to the species. The propensity has been observed, in the following well-known animals, to correspond to a scale of descending temperature, according to the following order:—1*st*, The bat; 2*dly*, the hedgehog; 3*dly*, the dormouse; 4*thly*, the marmot; 5*thly*, the hamster. Although many other animals are subject to the same law, it is only among those just enumerated that an exact comparison has been instituted.

A complete state of hybernation consists in the suspension of sensation and voluntary motion, in addition to a great decrease in the temperature of the body, and in the frequency of respiration. Its different degrees of intensity are well ascertained by the number of respirations in a given time, or, in its most perfect state, by the total suspension of all respiratory movements. The different species of the bat tribe are those of which the torpidity is the least profound; and the marmot probably experiences the greatest degree of vital suspension. The temperature of these animals during their lethargy depends in a great measure upon that of the external air, and is consequently variable. It is in general, however, superior to it by several degrees. It may descend to within a few degrees of the freezing point, but is not susceptible of reduction to that point, without producing either re-action of the vital functions or death. There is, therefore, contrary to the opinion of some of the older naturalists, a degree of external cold incompatible with the torpidity or existence of these animals. The species most easily rendered torpid, such as the bat, the hedgehog, the dormouse, the lerot, and the muscardine, cannot support a cold of 14° of Fahrenheit. A warmth of from 50° to 53° brings them again to life. Sundry mechanical means, such as different degrees of motion, serve to restore several of the last-named species without any increase of temperature; but to preserve them in a state of prolonged activity, a gentle warmth must be applied and continued.

It is evident, from these and other observations, that the sleep of mammiferous animals is not characterized by a uniform and constant duration. As it is dependent on the variations of the atmosphere, it will commence at an earlier, continue a longer, or be interrupted after a shorter period, according to the difference in the seasons of particular years, the skill which the animals may have exhibited in the choice of a protecting habitation, or the peculiar constitution of the species, or even of the individuals. The habit of storing up a supply of winter provisions also depends upon their greater or less degree of exposure to

[1] See the observations prefixed to the translation of *Spallanzani's Tracts*, before referred to.

the power of awakening influences. The hedgehog, for example, has been observed to form several separate magazines, to which it has recourse during the winter season; and the marks of its little feet have sometimes been traced on the surface of the surrounding snow.

The hybernation of the swallow is a point on which very dissimilar opinions have been promulgated. It now appears to be the prevailing belief that these birds migrate on the approach of winter to other and more genial climes, but that cases do occur in which such individuals as are prevented by circumstances from joining the "marshalled array," are enabled to survive the rigours of our northern winters by the power which their constitution possesses of assuming the torpid state; at least the occurrence of torpid swallows, however rare, is too well authenticated to be a matter of doubt.

It is said that the tanrec, a species of hedgehog found in Madagascar, becomes torpid for some months in the year. If this assertion is well founded, it affords the only known instance of torpidity in a mammiferous quadruped of a warm climate.

Many cold-blooded animals may be regarded as of the hybernating kind. Indeed the greater proportion of reptiles, insects, molluscous animals, &c. inhabiting cold countries, are very lethargic during the winter season, which they usually pass without food. They appear subject to the influence of this feeling even in warm climates; at least Humboldt describes certain reptiles in South America which pass a portion of the year buried in the earth, and which are only aroused by the occurrence of rainy weather or the excitement of violent means. "The manners of animals," says this enlightened observer, "vary in the same species, according to local circumstances difficult to investigate. We were shown a hut, or rather a kind of shed, in which our host of Calabozo, Don Miguel Cousin, had witnessed a very extraordinary scene. Sleeping with one of his friends on a bench covered with leather, Don Miguel was awakened early in the morning by violent shakes and a horrible noise. Clods of earth were thrown into the middle of the hut. Presently a young crocodile, two or three feet long, issued from under the bed, darted at a dog that lay on the threshold of the door, and, missing him in the impetuosity of his spring, ran toward the beach to attain the river. On examining the spot where the barbacon or bedstead was placed, the cause of this strange adventure was easily discovered. The ground was disturbed to a considerable depth. It was dried mud, that had covered the crocodile in that state of lethargy, or summer sleep, in which many of the species lie, during the absence of the rains, amid the llanos. The noise of men and horses, perhaps the smell of the dog, had awakened the crocodile. The hut being placed at the edge of the pool, and inundated during part of the year, the crocodile had no doubt entered, at the time of the inundation of the savannahs, by the same opening by which Mr Pozo saw it go out. The Indians often find enormous boas, which they call *uji*, or water-serpents, in the same lethargic state. To re-animate them, they must be irritated, or wetted with water."[1]

Upon the whole, naturalists seem to be of opinion that no species of animal is condemned to torpidity by any inherent property of its nature. It is a provisional faculty, dependent on external circumstances, and may be interrupted, postponed, or altogether prevented, by regulating the conditions under which the animal is placed.

The disposition of animals in relation to other individuals of the same species differs considerably. There are some which unite in couples and divide between them the cares of the family. This is usually the case among the various tribes of birds, and also among carnivorous quadrupeds; whilst the males of such as feed on vegetables, and which consequently find almost everywhere an abundant and easy nourishment, abandon to the mother the rearing and education of their young. It has also been observed, that among such birds as feed on living prey, the male is very assiduous in assisting his mate to procure a sufficient supply. But naturalists have erred in assigning the polygamous habit as a general characteristic of the gallinaceous kinds. The instinct to pair, or the habit of monogamy, is no doubt only bestowed on those species to which it is necessary for the rearing of their offspring, and differs considerably in the nature and permanence of the attachment, according to the position of the nest, *i. e.* whether it is built upon or above the surface of the ground. All birds which build on trees, as was long ago remarked by Lord Kames, are hatched blind, and almost without feathers, and consequently require the sedulous care of both parents. But the generality even of gallinaceous birds, which breed upon the ground, do likewise pair, though the hatching of the eggs is entirely confined to the female, who completes her task by leading the young to their proper food, which they are able immediately to pick up for themselves, being active and well feathered from their birth. The male, at the same time, continues to manifest a certain degree of paternal solicitude, by uttering the alarm-note on the approach of birds of prey, or other dangerous foes. Black game and wood-grouse, however, do not appear to pair at all; but in the spring a male bird assembles a certain number of females about him, which afterwards deposit their eggs, and rear their young altogether independent of the male parent. They are therefore polygamous in the proper acceptation of the term. Even among herbivorous quadrupeds pairing is rare, because the female can suckle her young while she herself is feeding; but the monogamous habit probably obtains among most carnivorous quadrupeds, and certainly among all carnivorous birds, because incubation leaves the female no sufficient time to hunt for food,[2] and because young birds cannot bear a long fast, and therefore require the assistance of both parents, while unable to provide for themselves. The association or fellowship of birds is either annual or for life; the former bond is the more usual, though eagles, crows, and several other species afford examples of a long-continued attachment.

Many birds assemble in autumn, winter, and early spring, into flocks, but as soon as the pairing season has commenced they again separate into pairs. Others again appear to be more gregarious during the breeding season than at any other period of the year, for example the gannet or soland-goose (*P. bassanus*); but this arises not so much from a love of fellowship with their kind, as from the accident of there being few places fitted for the purposes of nidification and the rearing of the young.

We have said that pairing is rare among such quadrupeds as feed on grass, because the female can feed herself at the same time that she is suckling her young. The roe-deer, however, among herbivorous quadrupeds, forms an exception to the general rule. On the other hand, there are several carnivorous quadrupeds which do not pair, but the young of which are left entirely dependent on the mother; that is to say, the latter is obliged both to capture her own food and to suckle her offspring.

Among gregarious quadrupeds which usually store up food for winter, pairing is probably necessary to prevent discord, and in this respect beavers are said to resemble those birds which place their nests upon the ground. As

[1] *Personal Narrative*, vol. iv. p. 380.

[2] See Kames's *Sketches*.

soon as the young are produced, the males abandon their stock of food to their mates, and live at large, but return frequently to visit them while they are suckling their young. Hedgehogs and most of the monkey kind pair. Seals are polygamous, and turtles leave their young to be hatched by the heated sand. Earwigs, spiders, bees, and woodlice (*onisci*), are amongst the few of the insect tribes which pay any attention either to their eggs or offspring. The young of the greater proportion of animals is produced in spring, when the supply of food is the most abundant, and when the long period which intervenes before the approach of winter enables them to acquire strength to support the rigours of that inclement season.

Though the period of gestation varies considerably in the different quadrupeds which feed on grass, yet the females are regularly delivered in spring, or early in summer, when the herbage is nutritive and abundant. The mare conceives in summer, carries 11 months, and brings forth in May. The same is nearly the case with the cow. The sheep and the goat are usually in season in November; they carry five months, and produce when grass has begun to spring. They love short, close herbage, upon which a horse or cow would barely thrive. The ass is in season about the beginning of summer, but she bears twelve months, and consequently brings forth likewise early in summer. Wolves and foxes copulate in December, but as they only bear five months, they bring forth in April, when the season has assumed a genial aspect, and animal food is as abundant as at any other season. If we were to guess what would probably be the rutting season of animals, we would say summer, especially in a northern country; and yet, to quadrupeds which carry their young only for four or five months, such economy would be injurious and improvident, as it would bring the time of delivery at an undue season, both for warmth and food.[1] There are a few exceptions to the above rule, which, however, in themselves, belong to an equally beautiful system of providential ordinances. Some gregarious and store-collecting animals, for example, bring forth in January, when their granary of provisions is still abundantly filled.

The season of pairing, or of production, among wild animals, usually takes place only once a year, and at a fixed period; but those which man has rendered domestic are observed to couple at all seasons. The species of warmer climates, when transported into colder regions, usually cease to pair, or at least their union is unproductive; and the same consequence generally follows a state of captivity. Among such species, however, as man has fairly reduced to a state of satisfied domestication, the individuals become much more prolific than in the wild state.

The season of love varies greatly among mammiferous animals. The greater proportion pair in spring and summer; but the wolf pairs in winter, the stag in autumn, and many domesticated animals at diversified periods throughout the year. Prolific union takes place among *varieties* of the same species; and it is by paying attention to these that the finer races of our domestic animals are maintained and continued. As the climate of northern countries causes several of our most valuable animals to degenerate (as it is called), it has been customary to obtain from time to time a male animal of a pure and noble race, which, when paired with an ordinary female, produces a breed scarcely inferior to the male parent; for it has been observed that, with few exceptions, the new produce assumes the characteristics of the father. Thus, in uniting a sheep of an ordinary kind with a ram of the Merino race, the first generation almost equals the father in beauty.

What is frequently called deterioration in animals is, more properly speaking, their natural assumption of those peculiar attributes which fit them for the inclemencies of climates uncongenial to their original nature. A Laplander is no more a deteriorated Asiatic of the Mongolian or Caucasian line, than a Georgian or Circassian is a highly refined Laplander; neither is the Shetland pony a deteriorated Arabian courser, any more than the steed of Araby is a thorough-bred shelty. Each has been enabled by a wise provision of nature to assimilate its character and constitution to the qualities of the climate in which it was destined to exist; and had it been incompetent to effect or undergo such assimilation, it would then indeed have deteriorated—that is to say, it would have died. If we admire the slim smooth elegance of the Italian greyhound, and regard the rough shaggy coat of the dog of Nova-Zembla as a deterioration, let us remember that that which is the beauty of the one would be the bane of the other; and what would then become of that forlorn agriculturist, whose business it is to drill the ice and to furrow the snow? The small stature and peculiar habits of the northern pony would have been as little fitted to sustain the fiery breath or the shifting sands of an eastern desert, as the graceful Arabian to withstand the cold and cloudy clime, and the rugged and precipitous mountains, of Lapland or Thule. Therefore, instead of being deteriorated, each ought rather to be said to exist in the best and most improved condition, according to the nature of its particular calling. Using the word, however, in its more usual acceptation, it may be stated that an animal seldom degenerates in its native country, but more frequently in those for the climate of which its constitution is not adapted. Each species appears to have a certain extent or circle of natural distribution, in the centre of which it not only most abounds, but also there shows itself in its finest and most characteristic proportions. As the places of its occurrence diverge from this centre of dominion, it becomes rarer, and exhibits a variation or considerable departure, at least in its external characters, from the primitive model. Thus the horses of Arabia and Barbary degenerate in Britain; and, to preserve the breed in purity, they must be frequently crossed by the original; but the Arabs themselves are very careful to prevent any mixture in the blood of their native and noble kinds, and would deem them deteriorated by such alliance.

In the tabular or abridged views of classification which we here present, it is our intention merely to exhibit the great primary divisions of the animal kingdom called *classes*. The secondary divisions into orders, and the further dismemberment of these into minor groups called families, genera, &c., will be illustrated when we come to treat of each class in particular under its proper head. Neither do we intend to trace the progress of classification from the earliest ages of scientific record; because, as the object of the naturalist is rather to ascertain the nature and relationship of things as they are, than as they were supposed to be, there is the less necessity for leaving our direct route, to trace either the origin or the progress of error. We shall proceed, after a few observations, at once to the system of Linnæus, which is in fact the basis of all that have succeeded, and without a knowledge of which it is impossible to understand either the merits or defects of more recent systems. Indeed, with the exception of the purely artificial classification of Klein, and the multiplied orders of Brisson and Vicq-d'Azir, all the systems which have appeared since the middle of last century are indebted more or less to the labours of the immortal Swede, and may be valued almost exactly in pro-

[1] Kames's *Sketches*.

portion to their share in the *lucidus ordo* of the Linnæan system. For example, the *Systema Regni Animalis* of Erxleben (1777) is nothing more than a revised edition of the *Systema Naturæ*, in which are engrafted, with no lack of skill, many additions both of species and genera; the whole being presented in a consecutive series, without the accustomed subdivision into the primary groups called *orders*. The *Prodromus Methodi Animalium* of Storr (1780) does not differ radically from the Linnæan system. The *Elenchus Animalium* of Bodaert (1787) is allied to it still more closely in every thing except its accuracy. Of Gmelin's work (1789) we need not speak, as it is a professed revisal (being the 13th) of the *Systema Naturæ*. And although no one will deny the merit of profound and original inquiry to the investigations of Blumenbach, most readily will those who are best acquainted with his labours admit, that in zoology he has wisely followed the footsteps of Linnæus. The six classes into which the German naturalist divides the animated creation, viz. *Mammalia*, *Aves*, *Amphibia*, *Pisces*, *Insecta*, and *Vermes*, correspond with those of the Linnæan arrangement, although their orders and genera are in some respects differently combined. His motto appears to have been *Multa fiunt eadem, sed aliter*. (Quintilian.)

The signal benefits conferred on natural history, in all its branches, by the learning and genius of Baron Cuvier, are known wherever the science has obtained a zealous and successful cultivator; and it cannot have escaped the notice of the critical observer, that after 30 years of profound and philosophical research into the mysteries of the animal kingdom, the most enlightened zoologist of the age should have finally reverted to a closer approximation to the Linnæan system, than had characterized his views at any former period of his brilliant career. When he first made known (in 1797), conjointly with M. Geoffroy, his new classification of mammiferous animals, his numerous genera were contained under no less than 14 different orders. Thirty years afterwards (in 1817) he published his *Règne Animal*, with many improvements in the composition and arrangement of the minor divisions, and with the addition of the order of which he is himself so bright an ornament, but otherwise composed (we speak at present of the mammalia alone) of primary divisions exactly the same in number, and nearly the same in nature, as those finally divulged and established by Linnæus himself just 60 years before.

Latreille, Dumeril, Desmarest, and Frederick Cuvier, are followers or coadjutors of the Baron, and with him are partakers in the modification and amendment of the Linnæan system. The venerable Lamarck has greatly signalized himself in a field which, it must be confessed, was obscure to the eye of Linnæus—that of the molluscous animals—which, under the name of Vermes Testacea, were but indifferently treated in the *Systema Naturæ*. The error appears to have lain in the greater attention which was bestowed on the shells themselves, or testaceous coverings, than on the animal inhabitants; and the consequence has been, that the conchologist of the old school ranks with the collector of china, whether old or new.

The names above enumerated are certainly among the foremost in the annals of modern science; and although, in addition to these, many more might be mentioned with honour as having contributed, by monographs or other partial though highly prized contributions, to the increase of knowledge, yet we are not aware that more than three systematists of acknowledged and wide-spread influence, or of what may be termed universal celebrity, remain unnoticed, of those who have essentially influenced the present condition of zoological science; we mean Fabricius, Illiger, and M. de Blainville. We have no hesitation in asserting, that as the writers first mentioned owe much of the success which has attended their labours to their having judiciously engrafted their own improvements on the original stock of the Linnæan system, so the authors last named, though not less highly gifted, have in a great measure sacrificed the utility of many original and enlightened views to the fond conceit of a new, and in some instances an incomprehensible, nomenclature.

The skill of Fabricius as an entomologist has never been surpassed, and it is therefore the more to be regretted that he should have been influenced in the formation of his system by other motives than a desire to perceive and point out the truth. But it is known that he was swayed as much by the ambitious hope of founding a new doctrine, of which he destined himself to be the oracle, as by the desire of proceeding directly in the path of nature. Hence his avowed enmity to the eclectic system of Latreille, which, during the opening career of that celebrated entomologist, he declared it to be his intention utterly to destroy. Yet the system of Latreille not only stands, but, when viewed in relation to the application of its general principles, has in a great measure superseded that of Fabricius. At the same time, the accurate discrimination and extensive knowledge of the latter, and the wide circle which his system embraces in detail, render it still indispensable for a knowledge of the species.

Illiger died young. His talents were such as to raise among his compatriots the highest hopes of his future eminence, and his death was a subject of just regret to all who knew what he had achieved so well at an early age, and who the more gladly lent themselves to the anticipation of what he would afterwards have accomplished had his life been prolonged. Of his classification it has been written by a competent judge: "Neque apud veterem, neque apud recentiorem quendam auctorem ullum systema invenerim, quod, tam sua perspicuitate, quam accuratione, Illigeriano magis commendari mihi videatur." Many of his genera are indeed remarkable for their felicitous construction and consonance with the natural arrangement. They have in consequence been readily adopted by his more fortunate fellow-labourers in the same field, in whose works they will remain, and be handed down in ample attestation of the author's genius; but the system itself will suffer a partition, and ere long cease to be practically known under the form in which it was originally promulgated, and this mainly in consequence of his having adopted so many new names.

M. de Blainville is still alive, and the longer he lives the better for the sciences of anatomy and physiology, neither of which contains in its modern annals the name of a more accomplished or enlightened expounder of its mysteries than his own; but in the character of a naturalist, and in connection with the subject of nomenclature, he unfortunately sins more than all his predecessors. He really miscalls the objects of zoology most sadly, yet his knowledge of the essential bases of the science is no doubt too profound to admit of his applying it without new and important results. Hence the pity that these should not at all times be stated in such terms as not only to amalgamate more closely with the kindred labours of his contemporaries, but to fall rather more clearly within the comprehension of ordinary minds.

As it is not our intention in the present rapid sketch to enter into the distribution of the animal kingdom beyond the greater divisions called classes, we shall not exhibit the systems of the two first-named authors further than to say, that the former attended almost exclusively to entomology, the latter chiefly to the mammalia and birds. When we come to the divisions of our subject under their separate heads, tabular views or more detailed ana-

lyses will be presented of the labours of these and other ingenious inquirers of the past and present times.

We have said that we regarded the system of Linnæus as the basis of all those by which it has been succeeded, and that without a knowledge of his classification it would be impossible to understand either the merits or defects of more recent systems. We shall therefore here present the classes into which the great Swedish naturalist divides the animal kingdom.

Division I.

A heart with two auricles and two ventricles; blood warm and red.

Class I.—Viviparous animals, or such as suckle their young; commonly called quadrupeds, but including also the cetacea or whales,	Mammalia.
Class II.—Oviparous animals, or birds.....	Aves.

Division II.

A heart with one auricle and one ventricle; blood cold and red.

Class III.—Animals breathing arbitrarily through lungs....................	Amphibia.
Class IV.—Fishes, or animals with gills...	Pisces.

Division III.

A heart with one ventricle, no auricle; blood cold and white.

Class V.—With antennæ; undergoing transformations. Insects.......	Insecta.
Class VI.—With tentacula, and undergoing no transformations. Worms,	Vermes.

It may be observed, that the deservedly popular system of Linnæus, though it does not profess to be a natural method of classification, actually is so in many of its parts; nor can it be denied that, on the whole, it usually brings together as many groups of natural genera as occur in most systems that have been promulgated, especially if we take into consideration the period at which it was composed, and the comparatively scanty materials within his reach. Linnæus was probably aware of the extreme difficulty, we might say at once of the utter impossibility, of a perfectly natural arrangement; for he confesses, in his *Philosophia Botanica*, his inability to define the great divisions called *orders*, on account of their being so connected with each other by various points of affinity, as to form a map rather than a linear series; and the observation may be applied with equal truth to the subjects of the animal kingdom. In regard to the excellence of his genera themselves, their consonance with nature is rendered still more evident, by the great proportion of those which Cuvier and Latreille have retained as leading generic divisions in their recent works,—certainly the most skilful approaches which have yet been made in the establishment of a natural system. It has been asserted, and we believe with truth, that such naturalists as are perpetually intent on the abstract theory of classification, rarely attain the highest excellence in the discrimination or definition of the species,—the only distinctions possibly which have a real foundation in nature, and upon an accurate and extensive knowledge of which alone their theoretical systems can be substantially and permanently built. At all events, it is admitted that Linnæus is a guide almost infallible, in as far as concerns his wonderful facility in discovering the minor natural groups. If he could have combined these as well as he has defined them, his possession of the sceptre would have been still undoubted.[1]

M. Virey, in the first edition (1803) of the *Nouveau Dictionnaire d'Histoire Naturelle*, divides the animal kingdom into three great tribes, in accordance with the nature and distribution of the nervous system. As he appears to have been among the first to attribute a due degree of importance to that system in the classification of animals, we shall here exhibit a view of his general arrangement.

Tribe Vertebrata.

Animals possessed of two nervous systems, the cerebro-spinal and the ganglionic......................	Heart with two ventricles and two auricles; blood warm, lungs cellular....................	Man and Mammalia. Birds.
	Heart with one ventricle and one auricle; blood cold.......................................	Reptiles and Fishes.

Tribe Invertebrata.

Animals possessed of a single nervous system surrounding the œsophagus, with ganglia and branches; the *sympathetic*................	A heart; branchiæ for respiration, mostly aquatic..	Mollusca. Cirrhipedes. Crustacea.
	No heart; some vessels; tracheæ for air or water..	Arachnides and Aptera. Insects, winged, hexapod. Annelides and Helminthides. Intestinal worms.

Tribe Zoophyta.

Nervous system composed of molecules more or less perceptible; no distinction of sexes............	Ascidia, inclosed in a tunic....................	Botrylli, &c.
	Radiated animals; composed of rays parting from a centre...	Echinodermata. Hydra and Polypus.
	United in Polypiers, or stony masses; coralligenous..	Corals and Ceratophytes. Madrepores and Sponges.
	Microscopical...	Infusory Animals.

The following summary will serve to illustrate M. Virey's views of the nature and characteristics of these three great divisions. We commence with the zoophytical tribe.

1*st*, *Zoophytes* are distinguished by an organic tissue of a very soft and pulpy nature, more or less diaphanous, and very contractile, though we cannot readily perceive its muscular fibres. Its fundamental character consists in the extreme division of its nervous molecules throughout the flesh of these animals. Except in the Echinodermata and some other radiated classes, we can scarcely assert the existence of a nervous system amongst them (on which account they are named *apathiques* by Lamarck). Each portion of the body having its nervous molecule and its par-

[1] *Horæ Entomologicæ*, part ii. p. 428.

ticular source of vitality, there is no common centre of sensation; thus division and generation are almost synonymous, and when individual parts are mutilated they are speedily reproduced. With these tribes the production of the species is in fact nothing more than a simple sprouting of a bud or offset, which separates itself from the maternal stalk. Zoophytical animals are of no sex, and thus resemble the agamous vegetables. The mouth is usually placed in the centre of the body, and is frequently surrounded by a species of unarticulated arms, radiating from a centre like the petals of many flowers. Several genera have only a single opening for the reception and rejection of the aliment. They have no viscera (excepting *cæca* in certain species); no heart, nor arterial nor venous vessels; no true circulation; no apparent organs of respiration. They are all aquatic, and water seems indeed the only fluid which pervades their economy. They may be called the cryptogamia of the animal kingdom. The sense of touch, and perhaps that of taste, seem the only ones enjoyed by these animals.

2dly, The *Invertebrata* present a greater complication of organs. Their principal character consists in a nervous system, extending itself, especially in the intestinal cavity, by numerous ramifications. In all the families of this great tribe, the nervous trunks surround the œsophagus, pass beneath the belly, and are furnished with many ganglions which supply branches to the different organs. That which is regarded as the brain in this tribe (named *sensible* by Lamarck) is nothing more than one or two ganglia situated above the œsophagus; but the particular distribution of the two nervous branches which spring from the collar of the gullet, and extend themselves over the body, gives rise to the divisions of *molluscous* and *articulated* animals established by Cuvier.

The last-named naturalist has observed, that in the mollusca the nervous system is composed of many ganglionic masses, dispersed throughout the organization, but connected by means of nervous filaments; and that the chief of these masses constitutes a kind of brain above the œsophagus. The mollusca have no skeleton; their muscles are attached to the skin, a soft contractile envelope, in which in many species are produced shells, or stony bodies of calcareous carbonate, formed by exudation or superimposed concretion. Besides the sense of touch, common to all animals, the mollusca are gifted with that of taste, and sometimes of sight; but the sense of hearing has not been remarked, except among the *Cephalopoda* or cuttle-fish. Their systems of digestion and secretion are rather complex; they are provided with a liver, and possess a circulating or vascular system, through which flows a humour or whitish sanies in place of blood. Their respiration is effected by aquatic or aerial branchiæ. The sexual organs are frequently united in the same individual.

Among the articulated classes (such as the crustacea, the arachnides, and insects) the nervous system consists of a double chord, extending from the head to the posterior extremity, and bearing knots or ganglia which correspond to the segments of the animal's body. The first ganglion above the œsophagus takes the place of what we call the brain in the higher animals, but it is not voluminous in proportion. All these animals are composed of segments or annular divisions, and their forms are elongated, and more or less cylindrical. Their skin or outer covering, always of a somewhat solid texture, becomes in many families hard, corneous, or even stony; and the muscles are attached to its interior. The greater number have articulated members, feet, wings, pincers, palpi, &c. Many of these animals have closed vessels; and the crustacea have a heart and branchiæ. Others, according to Cuvier, are nourished by simple imbibition. Those insects which undergo metamorphoses are furnished with tracheæ or air-vessels for respiration, dispersed over their bodies. The organs of the sense of hearing are not discernible except among the crustacea; taste is universal, and also sight, except among the worms. Their jaws always ply laterally. The sexual organs are usually separate.

Animal Kingdom.

3dly, The *Vertebrata* comprehend all those animals which have a nervous system composed of ganglia, called sympathetic, for the functions of the internal life; and another symmetrical nervous system, of which the principal portions are inclosed in the cranium and spinal column, and which sends off chords for the functions of the external life. These are the most perfect and most highly endowed of all animals; they are named *intelligens* by Lamarck, and they are always endowed with five senses, of which never fewer than four are situated in the head. They possess a heart, red blood, a liver, lungs in the species which live in air, and branchiæ in those which live in water. An articulated, bony, symmetrical skeleton, placed in the interior of the body, gives support and solidity to the different parts. Such are man, mammiferous animals, and birds, which have warm blood, and respire by cellular lungs; such also are reptiles and fishes, of which the blood is cold. In all, the mouth has two horizontal jaws, and the members are never more than four in number.

The preceding are M. Virey's views of the distribution and general characteristics of the different classes of the animal kingdom.[1] They contain a sound exposition of several of the substantial relations which exist between the different systems of the animal economy, and we present them to the reader even at the risk of afterwards repeating in part several essentialities of his doctrine, when we come to promulgate the views of his celebrated countryman and contemporary Baron Cuvier.

We shall next present a tabular view of the general distribution and primary divisions of animals according to the system of Lamarck. It will be observed that this author commences with the lowest tribes.

Animals without Vertebræ.

* Apathetic Animals. (*Apathiques.*)

1. Infusoria. 2. Polypi. 3. Radiata. 4. Vermes.	*Characters.* No brain nor elongated medullary mass; no special senses, forms various; rarely articulated.

(*Epizoaria.*)

* * Sensitive Animals. (*Sensibles.*)

5. Insecta. 6. Arachnides. 7. Crustacea. 8. Annelides. 9. Cirrhipedes. 10. Mollusca.	*Characters.* No vertebral column; a brain, and generally an elongated medullary mass; some distinct or special senses; organs of movement attached beneath the skin; formed symmetrically of equal parts.

Animals with Vertebræ.

* * * Intelligent Animals. (*Intelligens.*)

11. Pisces. 12. Reptilia. 13. Aves. 14. Mammalia.	*Characters.* A vertebral column, a brain and spinal marrow; distinct senses; organs of movement attached to parts of an interior skeleton; formed symmetrically of equal parts.

[1] *Mœurs et Instinct des Animaux*, tome i. p. 180.

The author of the preceding arrangement has entered upon the discussion of certain preliminary points connected with the subject of classification, which may be regarded as composing the *art* rather than the *science* of Zoology. He inquires (in his introduction to the *Hist. Nat. des Anim. sans Vert.*) what are the operations to be performed for the execution of a good distribution of animals, and for the establishment of the necessary divisions of that distribution? These operations he states to be as follows: 1*st*, To assemble animals together according to a principle which is not arbitrary, and so as to form a general series, whether simple or ramified: 2*dly*, To divide this general series into different kinds of lesser divisions, of which the one shall be subordinate to the other; and with that view to make choice of and submit to certain suitable and convenient principles (*principes de convenance*): 3*dly*, To fix the rank of each sort of division after one general principle, previously established; as, for example,

The rank of each primary group in the total series;
That of the classical divisions of each primary group;
That of the orders or families in each class;
That of the genera in each family; and
That of the species in each genus.

The execution of these three sorts of operations is regarded by Lamarck as indispensable; and that it is so has been long felt by naturalists, almost all of whom have more or less occupied themselves in the attempt, but always in an arbitrary manner—that is to say, without the previous establishment of principles deserving of general consent. The first of the operations alluded to—that which concerns the bringing together of species in such a manner as to form a general series—is an essential preparation, which ought to precede the other operations, and without which indeed the latter could not be executed. It tends, moreover, to enable us to discover the order of nature, with which it is so highly important that we should become acquainted. Although nature has necessarily followed a certain order in the formation of organized beings, and especially of animals, yet as she has now dispersed these animals, and commingled all the different races over the surface of the solid globe, or through the wide depth of liquid waters, the original order of formation is to a certain extent disfigured, and so far imperceptible. We are therefore obliged, with a view to its ascertainment, to search after some means by which we may attain to that discovery, and to work out some solid principles to lessen the chance of error. In regard to this, the most important step has been already attained, when we acknowledge the interest inspired by affinities or relations, and the necessity of understanding these, with a view to submit to them, as to a test, the various parts of our general distribution. It may thus be perceived, that in order to establish a good distribution of animals, in such a manner that its solidity shall run no risk of being enfeebled by the arbitrary nature of opinion, it is necessary first of all to assemble our species according to well-determined affinities; after which we may, without inconvenience, trace out the lines of demarcation which separate the groups called classes, and those other subordinate groups of which the establishment is so advantageous, provided the natural relations are in nowise compromised by their formation. It may perhaps be proper shortly to inquire into the nature of these relations, their different degrees, and the exact uses which it becomes us to make of such as we ascertain and acknowledge. We shall then be enabled with greater facility to determine the principles which it is fit to establish.

Relations, according to Lamarck, are those traits of esemblance or analogy which nature has bestowed, as well on her different productions when compared among themselves, as on the different parts of those same productions when compared with each other. These traits of resemblance and affinity are so necessary to be known and understood, that no methodical distribution can be established on a sure foundation, if the objects which it embraces are not arranged according to the law which they prescribe. Relations are of different orders, some being very general, others less so, and many altogether special or particular. Moreover, although, in general, relations belong to nature, all are not the direct result of her operations in regard to her productions; for among the relations which we perceive between the compared parts of different beings, there are many which result merely from a modifying cause. Thus the relations of exterior form, which are so apparent between the cetacea and fishes, can only be attributed to a property resulting from the dense medium which each inhabits, and not to any direct plan in the operations of nature in regard to both It is necessary then carefully to distinguish those obvious and acknowledged relations which pertain to the direct operations of nature in the progressive organization of animal life, from certain others, equally obvious and acknowledged, which result from the influence of local circumstances, or from the peculiar habits which different races have in some instances been forced to acquire.

Relations of the last-named nature, though certainly of greatly inferior value to the former, are by no means limited in their influence and exhibition to external characters alone; for it may be demonstrated that the external cause which possesses the power to modify the direct operations of nature frequently exercises an obvious influence on several internal organs. It becomes the more necessary then to establish certain rules, devoid of arbitrary qualities, to enable us justly to appreciate the nature and value of these relations; and it may be established as a principle in zoology, that it is from the interior organization that the most essential are to be obtained. This principle is well founded if it expresses the pre-eminence which ought to be accorded to general considerations, gathered from the interior organization, over those derived from external parts. But if, instead of using it in this manner, we apply it to particular cases of our own choosing, and without pre-established rule, it is capable of great abuse; and we shall arbitrarily assign to relations presented by such or such system of internal organs, a preference over certain others, although the relations of the latter may in reality be of greater importance. By this means, sufficiently convenient for the changeable views of individual authors, we admit into various parts of our distribution inversions in every way contrary to the order of nature.

It is true, as has been already observed, that a cause which modifies organization not only acts on the exterior parts of animals, but also produces various modifications in their internal structure. It follows, that it is incorrect to suppose that the relations which exist between the races, and especially between the genera, the families, the orders, or even in certain cases the classes of animals, can always be decided merely from the isolated consideration of any internal organ, arbitrarily selected. On the contrary, Lamarck is of opinion that the relations of which we speak cannot be suitably determined except by a consideration and comparison of the whole of the interior organization, and, auxiliarly, by that of certain special internal organs which assured principles have demonstrated to be the most preferable and important.

The second question proposed by M. Lamarck is the following: What are the principles by which we ought to be guided in our operations, so as to exclude from these

whatever is arbitrary? Our author is of opinion that it is by the precise discrimination of each sort of relationship, and by aid of a determination, substantial and explained, of the preference which ought to be accorded to one kind over another, that we shall discover principles proper to regulate all the parts of our general distribution of animals. It is necessary then to determine the principal kinds of relations which ought to be employed to attain this end, and then to fix the superiority in value which one kind possesses over another. The following is the classification of Lamarck in further illustration of this subject.

* *Relations between Comparative Organizations, deduced from the whole of their parts.*

These relations, though general, manifest themselves in different degrees, according as we seek for them among races compared in themselves, or among groups of animals of different races compared with each other. It is necessary then to distinguish several kinds.

First kind of general relations.—These seem immediately to connect races or species with each other. They are of necessity the first, because it is they which furnish the greatest of the relations between animals which differ from each other. The *zoologist* who determines it, taking into consideration all the parts of organization, as well interior as exterior, admits not of this sort of relation, unless when it presents the smallest and least important difference. We know that animals which resemble each other perfectly, both in their internal and external organization, can be nothing more than individuals of the same species. In this case the relation is not considered, as such animals offer no distinction. But those which present among themselves a difference, tangible, constant, and at the same time the smallest possible, are connected by the greatest and most immediate of relations, if they present elsewhere a great resemblance in all the parts of their interior organization, as well as in the greater proportion of their external features. And this sort of relation does not demand a consideration of the degree of composition or relative perfection of the animal organization, for it determines itself in all the ranks of the scale. It is so easy to seize, that every one acknowledges it at first sight; and it is by employing it that naturalists have formed those smaller portions of the general series called genera, notwithstanding the arbitrary nature of their limits. Thus, in this first kind of relation, which may be called the *relation of species*, the difference between the objects compared is the smallest possible, and need only be sought for in the particularities of form or of the external parts of individuals.

Second kind of general relations.—This embraces the agreements which exist between groups of different animals when compared together. It may be named the *relation of groups;* and, to acquire a knowledge of its nature, we must no longer occupy ourselves essentially with the particulars of the general form, nor with those of the external parts, but almost solely with the interior organization, considered in all its parts. It is this kind chiefly which ought to furnish the differences by which we distinguish the groups from each other; and it is inferior in one or more degrees to the first kind in the quantity of resemblances which exist between the compared objects. It serves to form the *families*, by connecting the genera with each other; to institute the *orders*, or the *sections of the orders*, by uniting several families; and, lastly, it determines the classical groups into which we ought to partition the general series. The relations of which we now speak cannot, however, be employed to determine the *rank* of the great masses of that series, but only to form diverse combinations for establishing and distinguishing these masses.

From the consideration of these relations, the two following principles may be deduced.

First principle.—The general relations of the second kind do not require a perfect resemblance in the interior organization of the compared animals. "Ils exigent seulement que les masses rapprochées se ressemblent plus entr'elles, sous ce point de vue, qu'elles ne le pourraient avec aucune autre." (*Anim. sans Vert.* tome i. p. 355.)

Second principle.—The greater and more general the compared masses, the more will such masses differ in their internal structure. Thus the *families* present a less difference in the interior organization of the animals by which they are constituted, than the *orders* or *classes*.

Third kind of general relations.—We may denominate *relations of rank* those which serve to determine the position in the great series, and which, proceeding from a fixed point of comparison, effectively show among the compared objects a relation, whether great or small, in the composition or perfection of the organization. This kind is obtained by comparing any organization whatever, taken in the totality of its parts, with any other given organization which may be presented as a point of departure or of comparison. It is then determined, by the resemblance, greater or less, which is found between the two compared structures, to what extent that which we compare departs from or approaches to that which is given as a point of comparison. We shall see that this sort of relation is the only one which ought to serve for regulating the rank of all those important primary masses into which we divide the animal kingdom.

If we consider the question concerning the choice of a particular organization, from or towards which to remove or approximate other organizations successively, according to their greater or less resemblance, it becomes evident that the selection ought to fall on one or other extremity of the animal kingdom (as in that case there would be no uncertain balancing), and the best known extremity should have the preference. Thus, in setting out from the most perfect and highly finished structure, we should, in the determination of all the ranks, proceed from the most composite to the most simple, and should close the series by the most imperfect and least organized of the whole.

Of all forms of structure, that of man, considered in its totality, is at once the most composite and complete. From this M. Lamarck concludes that the more any animal organization approaches that of the human race, the more it advances towards comparative perfection and its own completion. This being the case, the organization of man is with that author the point of comparison and departure from which to judge of the relation, whether near or distant, of every form of animal structure, and by which we are to determine the rank which those forms, or the groups which they constitute, ought to occupy in the general series. The organization alluded to, considered in the totality of its parts, furnishes the means by which to judge of the degree of composition and perfection of other animal structures also regarded in their totality. And in doubtful cases it is not difficult to rid ourselves of uncertainty and embarrassment, by having recourse to the fourth kind of relations, or to those principles which concern the comparison of the different organs separately considered, and establish a predominating value and influence among certain of those organs when compared with others. Thus, our point of departure or comparison being found, the rank of all the divisions may be assigned with facility by the aid of the principles which follow.

First principle.—For the determination of the rank of each mass in the series,—the most complicated and complete of animal organizations being selected as the point of comparison,—the more another form of animal structure, considered in the whole of its parts, resembles that of the fore-chosen, the more it will approximate towards it by its relations; and reciprocally in the converse cases.

Second principle.—Among the organizations of which the plans are different from that which comprehends the particular structure selected as the point of comparison, those which offer one or more systems of organs similar or analogous to such as form a portion of that with which they are compared, shall rank superior to those possessed of a smaller number of these organs, and, *a fortiori*, to those in which they are wanting

With the assistance of the three kinds of relations above indicated, and the principles deducible from them, M. Lamarck regards it as easy to determine the distinctions of species, and those of the various larger groups which species form; and to decide, in a manner by no means arbitrary, the rank and station of each group in the great series. If this be true, the science will cease to be as vacillating in its onward march as it has hitherto proved.

But our efforts would be incomplete, and would still leave too large a field for the exercise of arbitrary opinions, if no attempt were made to establish and define the value of *particular relations*,—that is to say, of those which are obtained by the comparison of particular internal organs, considered in an isolated manner in different animals.

** *Relations between similar or analogous parts taken separately in the organization of different animals, and compared with each other.*

The *fourth kind of general relations* merely embraces particular relations between unmodified parts. It is drawn from the comparison of parts separately considered, and which, in the system of organization to which they belong, offer no real anomaly. The consideration of this kind is sometimes of great consequence in assisting to decide in doubtful cases, when we are anxious to determine, among certain compared groups, to which the superiority of rank ought to be assigned. Such cases sometimes occur where the whole of the parts of the interior organization present no means of deciding, in an unarbitrary manner, to which of two organizations the superiority belongs. It is especially in the formation and position of the orders, sections, families, and even genera, of each class, and consequently in the assignment of the rank of all these inferior groups, that the employment of this fourth kind of relations is of advantage; because, in regard to such groups, the principle of the third sort of relations is frequently very difficult of application; and thus arbitrary modes of arrangement are introduced, most baneful to the science, by exposing the works of naturalists to a continual variation in the determination of the relations which ought to fix the composition of the groups, and their order of position. In fact, as many animals, really connected by the general characters of their class, present remarkable differences in certain of their interior organs, and yet at the same time exhibit equally striking resemblances in others, we feel that, in order to appreciate the degree of importance possessed by the relations which exist between particular organs, we must have recourse to certain regulating principles in our determinations, to avoid arbitrary conclusions. The two following principles are proposed by Lamarck, to enable us to appreciate the relations observable between particular internal organs in different animals compared with each other.

First principle.—Between two internal organs, or systems of internal organs, separately considered and compared, that of which nature has made the most general employment ought to have the pre-eminence assigned it in the value of the relations which it presents. According to this principle, the following is the order of importance which we ought to attribute to the particular organs which nature has employed in the interior organization of animals:—

The organs of digestion;	The organs of production;
The organs of respiration;	The organs of sensation;
The organs of movement;	The organs of circulation.

Thus, when we take into view the greatest generality of employment of the particular organs of which nature makes use in the interior organization of animals, we perceive that the organs of digestion occupy the foremost rank,—those of circulation the last. We have thus an order of value or precedence, in regard to these important organs, capable of regulating, in doubtful cases, the preference which one relation merits over another.

Second principle.—Between two different modes of the same organ, or system of organs, that which is most analogous to the mode employed in a superior or more composite and complete organization, merits the preference in the relations which it exhibits. If, for example, we desire to employ a relation afforded by the organs of respiration,—to judge of the preference which it deserves over that offered by other organs,—we are obliged, according to the principle above established, to keep in view the following consideration:—Although the system of organs provided for respiration is very widely employed in the organization of animals, since, with the exception of the polyped and infusorial classes, all the rest possess a respiratory system, yet the mode of that system not being the same in all the classes by which it is exercised, we assign a higher value to the true *lung* than to the *branchia*, to the latter than to the *aeriferous tracheæ*, and to these than to the *aquiferous tracheæ*. According to this view, we may judge whether the mode of respiratory organs of which we wish to employ the relation, is sufficiently high in value to permit our yielding to it a preference over a relation deduced from some other kind of organs.

The *fifth kind of relations* embraces the *particular relations* observable between the modified parts. It requires that, among the parts compared, we should discriminate between that which is due to the real plan of nature, and that which pertains to the modifications which that plan has experienced from accidental causes. Thus this class of relations is derived from parts which, considered separately in different animals, are not in the state in which they ought to be, according to the plan of organization to which they belong. To judge of the degree of importance which ought to be accorded to a relation, and the preference which it deserves over another, it is a matter of no slight consequence to distinguish if the form, the increased or diminished development, or even the entire disappearance of the particular organs under consideration, belongs to the plan of organization of the animals subjected to such modifications; or whether the state of these organs is not rather produced by a modifying and determinable cause, which has altered or annihilated that which nature had executed, and would have maintained, but for the influence of that later cause. "For example," says Lamarck, "it would have been impossible for nature to furnish a head to the *infusoria*, the *polypi*, or the *radiata*, &c.; for the condition of these bodies, and the degree of their organization, did not permit it; and it was only on arriving at the class of insects that a genuine head could be supplied." Now, as nature never retrogrades in her operations, we naturally expect, that when once arrived at the formation of insects, and consequently of *heads*, the recipients of the special senses, all animal organizations

superior in composition to that of insects will also exhibit these organs. This, however, is not universally the case; because no distinct head is observable among the *annelides*, the *cirrhipedes*, and many *mollusca*, all of which are generally regarded as superior to the class of insects. "Une cause étrangère à la nature, en un mot, une cause modifiante et déterminable, s'est donc opposée à ce que les animaux cités soient pourvus d'une véritable tête." (*Anim. sans Vert.* tome i. p. 363.) And that cause appears to have operated sometimes by hindering to a greater or less extent the development of that part of the body, and at other times by effecting its complete destruction. We find the same thing in regard to eyes and teeth, and to various other parts both of the internal and external structure; because a modifying cause has had the power to alter, enlarge, diminish, or even to effect the total disappearance of these organs. We may perceive, then, that the relations obtained from the consideration of changed or modified parts must be of very inferior value to those furnished by the same parts existing in a state conformable to the plan of nature. Hence results the following

Principle.—Whatever nature has directly formed deserves a pre-eminence in value over that produced by a fortuitous cause, which has modified the work of nature; and in the choice of a relation to be employed, we should assign the preference to every organ, or system of organs, which we find existing as it ought to do according to the plan of organization of which it forms a part, over that organ, or that system of organs, of which either the condition or existence has resulted from a modifying cause, extraneous to original nature.

When two different organs, between which a choice is to be made, are both found to be changed or altered by a modifying cause, the preference should be given to that which is least removed by such a modification from the condition in which it would have existed according to the plan of organization of which it formed a part.

The *third question* proposed by M. Lamarck is as follows:—What disposition or mode of arrangement should be given to the general distribution of animals, so as to render it conformable to the order followed by nature in the production of these beings? To resolve this question, we must also endeavour to deduce some principle from nature herself, with a view to such conformity; for if we were to determine the general distribution of animals according to the progression which exists in the animal organization, it appears that we might, in that progression, proceed with as much reason from the most composite to the most simple, as from the most simple to the most composite. Such a proceeding, however, could not rest on a proper basis; for we shall find that nature, consulted in the order of her operations in regard to animals, indicates the following principle, which excludes all arbitrary selection:—*Nature always operating in a gradual manner, and consequently never producing animals otherwise than successively, has obviously proceeded in such a production from the most simple towards the most complex.* We ought, therefore, in our general distribution, to imitate the order which nature herself has followed. "J'ai, en effet, montré," says Lamarck, "dans ma *Philosophie Zoologique* (tome i. p. 269), que, pour rendre la distribution générale des animaux conforme à l'ordre qu'a suivi la nature en produisant toutes les races qui existent, il fallait procéder du plus simple vers le plus composé,—c'est-à-dire, qu'il était nécessaire de commencer cette distribution par les plus imparfaits des animaux, et les plus simples en organisation, afin de la terminer par les plus parfaits, par ceux qui ont l'organisation la plus composée." He further observes, in his *Anim. sans Vert.* "Cet ordre est le seul qui soit naturel, instructif pour nous, favorable à nos études de la nature; et qui puisse, en outre, nous faire connoître la marche de cette dernière, ses moyens, et les lois qui régissent ses opérations à leur égard." Although we may find it less pleasant or conformable to our habitual taste to present at the head of the animal kingdom creatures of the most limited perceptions, excessively minute in size, and of scarcely any consistence in their parts,—yet as in all things it is necessary to consider the end in view, and the means which conduct towards it, Lamarck is of opinion that the arrangement established by usage in the distribution of animals is precisely that which leads us away from the point in view, as well as the least favourable for our instruction, and that it opposes the greatest number of obstacles in the way of our perceiving the plan, the order, and the means employed by nature in her operations concerning the animal world.

If in the study and examination of living bodies we had no other object in view than to distinguish the one from the other by characters deduced from their external forms—and if we were not desirous to regard their various and wonderful faculties otherwise than as simple matters of amusement, not altogether unfitted to excite the curiosity of a leisure hour—then the most ordinary and artificial system would suffice; for in that case it would be useless to occupy ourselves with researches concerning the affinities of animals, or to study their internal structure. But all naturalists are now agreed regarding the high importance of these affinities, and the necessity of holding them ever in view in our general arrangement of the animal kingdom. The bat is no longer classed with birds merely because, like them, it wings its way through the air; nor are seals or whales regarded as fishes because the dense nature of the medium which they inhabit requires a somewhat analogous form; neither are cuttle-fish and polypi confounded together, though the mouth of each is surrounded by numerous arms.

We have dwelt at greater length than we intended on the system of Lamarck, or rather on the views by which he seeks to illustrate the principles on which his system professes to be built. Though occasionally prolix, and sometimes rather obscure, his observations, on the whole, are well deserving of an attentive consideration. Like most of his countrymen, he is unfortunately more regardful of secondary causes, and more anxious to illustrate their fitness and sufficiency, than he is ready to acknowledge the source from which they spring, or to admire the wisdom and beneficence of their providential institution.[1]

[1] "The doctrine of Epicurus, that the Deity concerns not himself with the affairs of the world or its inhabitants, which, as Cicero has judiciously observed (*De Nat. Deor.* lib. i. ad calcem), while it acknowledges a God in *words*, denies him in *reality*, has furnished the original stock upon which most of these bitter fruits of modern infidelity are grafted. Nature, in the eyes of a large proportion of the enemies of revelation, occupies the place, and does the work, of its great Author. Thus Hume, when he writes against miracles, appears to think that the Deity has delegated some or all of his powers to nature, and will not interfere with that trust (*Essays*, ii. 75); and, to name no more, Lamarck, treading in some measure in the steps of Robinet (who supposes that all the links of the animal kingdom, in which nature gradually ascends from low to high, were experiments in her progress towards her great and ultimate aim, the formation of man—Barclay *on Organization*, &c. 263), thus states his opinion:—"La nature, dans toutes ses opérations, ne pouvant procéder que graduellement, n'a pu produire tous les animaux à la fois; elle d'abord n'a formé que les plus simples; et passant de ceux-ci jusques aux plus composés, elle a établi successivement en eux différens systêmes d'organes particuliers, les a

Animal Kingdom.

We shall now proceed to the system of another naturalist, also highly accomplished in the science, M. Dumeril, the friend and pupil of Baron Cuvier, and to whose collection of the oral demonstrations of his great master we were originally indebted for the publication of the *Leçons d'Anatomie Comparée.*

Animal Kingdom.

Table of the Classification of Animals, according to the System of Dumeril.

Internally articulated; vertebrated;	with mammæ; viviparous			1. MAMMIFERÆ.
	without mammæ; oviparous;	lungs;	feathers, wings	2. BIRDS.
			neither feathers nor wings	3. REPTILES.
		no lungs; branchiæ		4. FISHES.
Externally articulated; invertebrated;	articulated members;	tracheæ		5. INSECTS.
		branchiæ		6. CRUSTACEA.
	no articulated members			7. WORMS.
Not articulated;	distinct respiratory organs; vessels			8. MOLLUSCA.
	no respiratory organs; no vessels			9. ZOOPHYTES.

The ensuing tabular view exhibits the classification proposed by M. de Blainville. We shall leave the reader to judge for himself of the propriety of introducing so many new appellations for groups constructed long ago. His nomenclature is no doubt intimately connected with his views of the structure and physiology of animals, and is highly approved of and adopted by many competent judges of the science.

SYNOPTICAL TABLE of the PRIMARY, SECONDARY, TERTIARY, and QUATERNARY DIVISIONS of the ANIMAL KINGDOM, denominated *Sub-Kingdoms, Types, Sub-Types,* and *Classes,* by M. de Blainville. From the *Principes d'Anatomie Comparée* of that author.

ANIMAL KINGDOM.

- *I. Sub-Kingdom.* Regular or ARTIOMORPHOUS Animals. ARTIOZOAIRES.
  - articulated
    - *Type I.* interiorly. OSTEOZOAIRES.
      - *I. Sub-Type.* Provided with mammæ and VIVIPAROUS. ...hairs — *Classes.* 1. PILIFERES or MAMMALIA.
      - *II. Sub-Type.* Without mammæ. OVIPAROUS. Provided with
        - feathers — 2. PENNIFERES or BIRDS.
        - scales — 3. SQUAMMIFERES or REPTILES.
        - naked skin — 4. NUDIPELLIFERES—AMPHIBIA.
        - fins — 5. PINNIFERES or FISHES.
    - *Type II.* exteriorly. ENTOMOZOAIRES, or articulated animals. With appendages,
      - articulated to the number of
        - 3 pair — 6. HEXAPODES.
        - 4 pair — 7. OCTOPODES.
        - 5 pair — 8. DECAPODES.
        - variable — 9. HETEROPODES.
        - 7 pair — 10. TETRADECAPODES.
        - = the segments — 11. MYRIAPODES.
      - not articulated — 12. CHITOPODES.
      - none — 13. APODES.
  - sub-articulated — *Type III.* MALENTOZOAIRES or MOLLUSCARTICULES
    - 14. NEMATOPODES.
    - 15. POLYPLAXIPHORES.
  - not articulated — *Type IV.* Malacozoaires. Molluscous animals. The head
    - distinct — 16. CEPHALOPHORES.
    - not distinct — 17. ACEPHALOPHORES.
- *II Sub-Kingdom.* Radiated or ACTINOMORPHOUS Animals. ACTINOZOAIRES.
  - sub-radiated — 18. ANNELIDAIRES.
  - normal or true
    - 19. CERATODERMAIRES.
    - 20. ARACHNODERMAIRES.
    - 21. ZOANTHAIRES.
    - 22. POLYPIAIRES.
    - 23. ZOOPHYTAIRES.
- *III. Sub-Kingdom.* Irregular or HETEROMORPHOUS Animals. HETEROZOAIRES
  - 24. SPONGIAIRES.
  - 25. MONADAIRES or MOLECULAIRES.
  - 26. DENDROBITHAIRES.

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multipliés, en a augmenté de plus en plus l'énergie, et les cumulant dans les plus parfaits, elle a fait exister tous les animaux connus avec l'organisation et les facultés que nous leur observons." (*Anim. sans Vertèbr.* i. 123.) Thus denying to the Creator the glory of forming those works of creation, the animal and vegetable kingdom (for he assigns to both the same origin, *ibid.* 83), in which his glorious attributes are most conspicuously manifested; and ascribing them to nature, or *a certain order of things,* as he defines it (214)—a blind power, that operates necessarily (311), which he admits, however, to be the product of the will of the Supreme Being (216). It is remarkable, that in his earlier works, in which he broaches a similar opinion, we find no mention of a Supreme Being. (See his *Système des Animaux sans Vertèbres, Discours d'Ouverture.*) Thus we may say, that, like his forerunner Epicurus, *Re tollit,* dum *oratione relinquit Deum.* But though he ascribes all to *nature,* yet, as the *immediate* cause of all the animal forms, he refers to the local circumstances, wants, and habits of individual animals themselves: these he regards as the modifiers of their organization and structure (162).

Let us here note, that M. Desmoulins, in the 2d edition of Dr Magendie's *Physiology* (1825), has exhibited a system in which the principles of Cuvier and De Blainville are joined in one.

A learned and ingenious Scotsman, Mr William Sharpe Macleay, is the author of several profound and original views in natural history. The unbroken and continuous succession, or linear series, in which systematic writers had previously regarded the objects of their contemplation, was first deviated from by Lamarck, who, in his supplement to the first volume of his *Animaux sans Vertèbres*, presented the *Invertebrata* in a double subramose series, consisting of articulated and inarticulated animals. The following are the principal bases of Mr Macleay's system.[1]

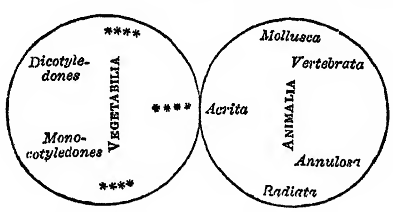
1. That all natural groups, whether kingdoms or any subdivision of them, return into themselves; a distribution which Mr Macleay expresses by circles.

2. That each of these circles is formed precisely of *five* groups, each of which is resolvable into five other smaller groups, and so on till we reach the extreme term of such division.

3. That proximate circles or larger groups are connected by the intervention of lesser groups, denominated *osculant*.

4. That there are relations of analogy between the corresponding points of contiguous circles.

The author has represented his system by tables of circles, inscribed with the names of the five primary divisions of each group. The following table exhibits his general view of the animal and vegetable kingdoms:



It will be perceived by the preceding diagram, that Mr Macleay divides the animal kingdom into five great sub-kingdoms, viz.

1. Acrita, composed of the *infusoria*, the *polypi*, the *corallines*, the *tæniæ*, and the least organized of the *intestinal worms*.

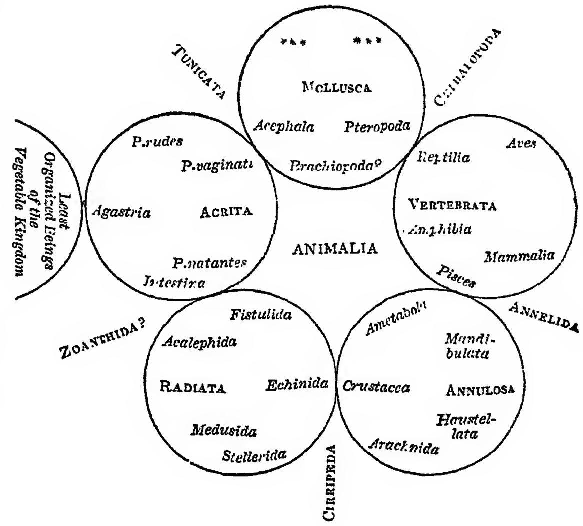
2. Radiata, containing *medusæ*, *star-fish*, *sea-urchins* or *echini*, and others.

3. Annulosa, consisting of *insecta*, *arachnida*, and *crustacea*.

4. Vertebrata, constituted by *beasts*, *birds*, *reptiles*, *amphibia*, and *fishes*.

5. Mollusca, including the numerous tribes of *shell-fish* or *marine testacea*, *fresh-water shells*, *snails*, *slugs*, &c. which, from the analogies presented by their soft or mucous substance, the peculiarities of their nervous system, and the general imperfection of their senses, appear as it were to return again to the *acrita*, though allied to the *vertebrata* by characters drawn from the possession of a heart and a circulating system.

The ensuing set of circles exhibits the further subdivision of the five sub-kingdoms into classes.



The *osculant* classes are such as are placed between the circles. In the molluscous circle two classes are still wanting to complete the quinary arrangement of that great division. According to Mr Kirby, the number *five*, assumed by Mr Macleay as a principal basis of his system, and as consecrated in *nature*, ought to yield to the number *seven*, which is consecrated both in *nature* and *scripture*. Metaphysicians enumerate *seven* principal operations of the mind, musicians *seven* principal tones, and opticians *seven* primary colours. In scripture, the abstract idea of this number is, *completion*, *fullness*, *perfection*. Mr Kirby seems to think that Mr Macleay's *quinaries* may be found resolvable into *septenaries*, in consequence of future investigations.[2]

We shall enter at greater length into a detailed expo-

To show the absurd nonplus to which this his favourite theory has reduced him, it will only be necessary to mention the individual instances which, in different works, he adduces to exemplify it. In his *Système* he supposes that the webfooted birds (*Anseres*) acquired their natatory feet by frequently separating their toes as far as possible from each other in their efforts to swim. Thus the skin that unites these toes at their base contracted a habit of stretching itself; and thus in time the web-foot of the duck and the goose was produced. The waders (*Grallæ*), which, in order to procure their food, must *stand* in the water, but do not love to *swim*, from their constant efforts to keep their bodies from submersion, were in the habit of always stretching their legs with this view, till they grew long enough to spare them the trouble!!! (13). How the poor birds escaped drowning before they had got their web-feet and long legs the author does not inform us. In another work, which I have not now by me, I recollect he attributes the long neck of the camelopard to its efforts to reach the boughs of the mimosa, which, after the lapse of a few thousand years, it at length accomplished!!! In his last work he selects as an example one of the *Moluscæ*, which, as it moved along, felt an inclination to explore by means of touch the bodies in its path: for this purpose it caused the nervous and other fluids to move in masses successively to certain points of its head, and thus in process of time it acquired its horns or tentacula!! (*Anim. sans Vertèbr.* i. 188.) It is grievous that this eminent zoologist, who in other respects stands at the head of his science, should patronize notions so confessedly absurd and childish." (*Introduction to Entomology*, by Kirby and Spence, vol. iii. p. 349.)

[1] See *Horæ Entomologicæ*, and Kirby & Spence's *Introduction to Entomology*, vol. iii. p. 12.

[2] *Introduction to Entomology*, vol. iii. p. 15. The quinary system, in its application to insects and other annulose animals, is pretty fully developed by its ingenious author in his *Horæ Entomologicæ*, already more than once referred to. An excellent paper by Mr Vigors, on the classification of birds, in accordance with the same system, will be found in the 14th volume of the *Transactions of the Linnæan Society*.

sition of the quinary system of arrangement under the articles *Entomology* and *Ornithology*.

Cuvier divides the animal kingdom into four principal branches. Setting aside all accessory and artificial characters, he proceeds upon the consideration of the essential structure of animals, and thus deduces four great groups or separate types of form, to one or other of which all the minor divisions may be ultimately referred.

In the first of these forms the brain, and the great central trunk of the nervous system called the spinal marrow, are protected by strong bony coverings—the cranium and vertebral column. To the sides of that column are attached the ribs and the bones of the anterior and posterior members. All the classes of this primary division are provided with red blood, a muscular heart, a mouth with two horizontal jaws, and special organs of vision, hearing, taste, and smell, placed in the head or upper and anterior portion. They have never more than four members; their sexes are always separate; and they nearly resemble each other in the distribution of their medullary masses, and the principal branches of their nervous system. On examining more narrowly the constituent parts of the classes which compose this great assemblage, it is easy to discover many striking analogies both of form and structure, even in those groups which are most distantly related to each other; and from the human species to the last of the fishes there exists an obvious conformity to the same general plan. The name of VERTEBRATED ANIMALS is bestowed on this division, on account of their being possessed of a vertebral column or back-bone. The following are the principal groups or classes into which it is further divisible.

FIRST PRIMARY DIVISION: ANIMALIA VERTEBRATA.

Class 1*st*. Man, mammiferous land-animals, and cetacea.
Class 2*d*. Birds.
Class 3*d*. Reptiles.
Class 4*th*. Fishes.

The second great division possesses no skeleton. The muscles are attached to the skin, which forms a soft contractile envelope; and many of the species are protected by hard coverings, commonly called shells, which are supposed to occupy in the cutaneous system of this form of animal life the same station as the mucous membrane of the preceding division. The nervous system is contained along with the viscera within this general envelope, and is composed of many dispersed portions, of which the principal, placed above the œsophagus, may be regarded as representing the brain. Of the four special senses it is impossible to discover the organs of more than two, taste and sight; and even of these the last is frequently wanting. The organs of hearing are visible only in one family. The system of circulation is however complete; there are particular organs for the performance of respiration; and the functions of digestion and secretion are almost as complicated as in the vertebrated classes. The subdivisions of this second form are called MOLLUSCOUS ANIMALS; and although the external configuration of their parts does not exhibit the same agreement as that of the vertebrated classes, there is always a corresponding resemblance in their essential structure and functions. The following are the classes of this branch of the animal kingdom.

SECOND PRIMARY DIVISION: ANIMALIA MOLLUSCA.

Class 1*st*. Cephalopoda, *e. g.* cuttle-fish, nautili, belemnites, argonauts, &c.
Class 2*d*. Pteropoda. Genus Clio, &c.
Class 3*d*. Gasteropoda. Slugs, snails, and numerous groups of turbinated shells.
Class 4*th*. Acephala. Oysters, mussels, and other bivalve shells, &c.
Class 5*th*. Brachiopoda. Terebratulæ, &c.
Class 6*th*. Cirrhopodes. Barnacle shells, &c. Lepas and Triton. (Linnæus.)

The third great preponderating form is represented by insects and other analogous classes. Their nervous system consists of two long ventral or sublateral chords, which swell out at intervals into knots or ganglia. The first of these ganglia, placed *above* the œsophagus, is analogous to the brain, although it does not exceed in size and scarcely in importance the ganglia of the lengthened cords, with which it communicates by means of a ring which embraces the œsophagus like a collar. The general covering of the body in this division is sometimes hard, sometimes soft, and is divided into segments by a certain number of transverse incisions. The muscles are always attached to the interior, and the body is usually, though not universally, provided with articulated members. It is among the classes of this form that we begin to perceive the passage from a system of circulation in closed vessels called arteries and veins, to nutrition derived from imbibition; and a corresponding passage from respiration in circumscribed organs to that performed by tracheæ or air-vessels, distributed over the whole body, is likewise observable. The organs of taste and sight are the most distinct in this branch; the organ of hearing is apparent only in a single family, although we can scarcely doubt that the sense exists in others in which the organ has not been ascertained. The following classes are ranked under this great form.

THIRD PRIMARY DIVISION: ANIMALIA ARTICULATA.

Class 1*st*. Annelides. Serpulæ, nereids, leeches, earthworms, the hair-eel, &c.
Class 2*d*. Crustacea. Crabs, lobsters, shrimps, &c.
Class 3*d*. Arachnides. Spiders, scorpions, mites, &c.
Class 4*th*. Insecta. Beetles, flies, butterflies, &c.

In the three preceding divisions, the organs of movement and of sensation are disposed symmetrically on both sides of an axis, with an anterior and posterior portion differing from each other. Among the zoophytes, which form the last great division, the organs are usually disposed in a radiated form. They approach the nature of plants in the extreme simplicity of their structure. They have no distinct nervous system, nor organs of the special senses; and it is barely possible to detect in a few of the species some slight vestige of the circulating system. Their respiratory organs are almost always on the surface of their bodies. The greater proportion of the classes exhibit no other intestine than a sack or cæcum, and the composition of the last groups of all presents only a homogeneous pulpy mass, sensible, and endowed with motion. From a consideration of their most usual forms, the classes of this order are named RADIATED ANIMALS. They are as follows:—

FOURTH PRIMARY DIVISION: ANIMALIA RADIATA.

Class 1*st*. Echinodermata. Star-fish, sea-urchins, &c.
Class 2*d*. Entozoa. Intestinal worms.
Class 3*d*. Acalephæ. Sea-nettles, actiniæ, medusæ, &c.
Class 4*th*. Polypi. Corals, madrepores, sponges, &c.
Class 5*th*. Infusoria. Infusory and other microscopical animals.

Such are the great outlines of a system which, considered in its generality, is certainly the most satisfactory which has yet appeared. Particular departments may have been filled up, modified, and perhaps improved by ingenious observers, sedulous within a limited sphere (and of these ameliorations we shall be careful to avail ourselves when we come to enter upon a detailed view of each of the classes of the animal kingdom); but the construction and position of the principal groups, their real as well as relative characters, are developed in the system of the great French anatomist, in a manner more clear and accordant with nature than in any other yet promulgated. We shall therefore in the course of this work adhere, with some slight transpositions, the reasons for which will be stated in their proper place, to the classes of Baron Cuvier. The greater extent and importance of some of these, in comparison with others, will induce us to bestow more attention and a larger space to their illustration; and as certain of the primary divisions, such as the Mollusca and Radiata, contain a greater number of classes, if not of less importance, at least by no means so strongly characterized or contradistinguished from each other as are those of the vertebrated tribes, we shall, in presenting the history and nomenclature of such classes, group them together in such a manner as to exhibit them to the reader either under one of the great primary divisions, or as an intermediate subdivision, containing one or more classes. For example, the article MOLLUSCA of this work will present consecutively under a single head the history and classification of the six classes contained in the second primary division so named;—but the four classes of vertebrated animals will be each discussed in a separate treatise. Thus mammiferous animals, birds, reptiles, and fishes, will form the articles MAMMALIA, ORNITHOLOGY, REPTILIA, and ICHTHYOLOGY. The Classes of the third primary division, viz. Annelides, Crustacea, Arachnides, and Insecta, will (with the exception of the first, referred to Helminthology) likewise be treated of under distinct heads, in the alphabetical order, of the following terms:— CRUSTACEA, ARACHNIDES, and ENTOMOLOGY. In regard to the fourth primary division, that of the radiated animals, commonly called Zoophytes, the first class, named ECHINODERMATA, will be treated of separately under its own title; the second class, *Entozoa*, which contains the intestinal worms, will be grouped with the Annelides or red-blooded worms (as above excepted from the third primary division); and these two classes will be treated of together under the article HELMINTHOLOGY. The remaining classes of the Animalia Radiata, that is to say, the Acalephæ, the Polypi, and part of the Infusoria, as they form the last links of the animal kingdom, will come to be discussed with greater propriety at the concluding stage of this work, under the head of ZOOPHYTES. Finally, that portion of the infusorial class which we have excepted in the above distribution will be found described in the present volume under the word ANIMALCULE. This completes the exposition of our zoological system.

The following enumeration exhibits a view of the terms under which the principal subjects of zoology will be explained and illustrated in the course of this work.

Systematic Arrangement.	*Alphabetical Arrangement.*
Mammalia.	Animalcules.
Ornithology.	Arachnides.
Reptilia.	Crustacea.
Ichthyology.	Echinodermata
Mollusca.	Entomology.
Crustacea.	Helminthology.
Arachnides.	Ichthyology.
Entomology.	Mammalia.
Echinodermata.	Mollusca.
Helminthology.	Ornithology.
Zoophytes.	Reptilia.
Animalcules.	Zoophytes.

(J. W.)

ANIMAL *Magnetism*. See MAGNETISM, *Animal*.

ANIMALCULE.

ANIMALCULE, a diminutive term (from the word animal), applied by naturalists to those minute beings which become apparent in various fluids when subjected to the microscope. They were named infusory animals (*Infusoria*) by Müller, one of the most celebrated observers in this department of zoology; and the appellation, however inapplicable, now occurs in the majority of scientific publications. Of course it applies with propriety only to such species as are developed through the medium of infused substances. Now we know, that of 400 species of Infusoria (commonly so called) described by Müller himself, not a sixth part were observed in any kind of infusions; whilst the remainder inhabited the most translucent waters, and speedily died when placed in impure or corrupted liquids. Even the word animalcule (or little animal) does not convey a positive or sufficiently restricted idea in relation to this particular class; because mites and certain polypi are extremely minute in their dimensions, and equally require the aid of microscopical investigation; and thus the term microscopics (*microscopiques*), recently proposed by M. Bory de St Vincent, is not less faulty than its predecessors. The size of an animal, in fact, bears no essential relation to the other conditions of its organization; and therefore we cannot infer its nature with any certainty from a knowledge of its dimensions. At the same time it must be admitted, that the most simply organized, both of plants and animals, are also the most minute; and thus the Infusoria may be regarded as possessed of certain characters in common. We here adopt the word Animalcule, chiefly because it is the most familiar to the English reader.

The subjects of our present observations may be thus defined:—*Animals invisible to the naked eye;*[1] *more or less translucent; unprovided with members* (the caudal, and other appendices, with which certain species are furnished, being scarcely regardable as such); *no perceptible eyes; contractile in whole or in part; endowed with the sense of touch; deriving nourishment by absorption; generation* (when not apparently spontaneous, and consequently incomprehensible) *effected by division, or by the emission of gemmules or oviform bodies; inhabitants of liquids.* They are the smallest and most simple of living creatures, but not less perfect than the other tribes; for though they possess the fewest faculties, their means are in every way adequate to their wants, and their vital energies proportioned to their sphere of enjoyment.

Among microscopical animals we find many species which, in their aspect and structure, present no analogy

[1] The *Volvox globator*, and a few others, which are just discernible without the aid of a microscope, form exceptions to the above character.

to other forms of animal life: they are merely moving molecules of the simplest organization, the exact nature of which it is sometimes difficult to determine, and which involve in deeper obscurity the mysterious line of demarcation by which we so often seek in vain to separate the animal from the vegetable kingdom. If, however, the true distinction between plants and animals consists chiefly in the irritability and power of contraction possessed by the latter, then the Infusoria, which are strongly endowed with these attributes, are indeed so far removed from the vegetable kingdom, that the name of Zoophytes, or animal plants, is inapplicable to the class to which they belong. In the extreme simplicity of their structure, they no doubt present some analogy to the least complicated tribes of plants, such as the algæ and others; but it is a mere analogy, and not a connection of affinity,—for no alliance between these kingdoms has ever been demonstrated, although certain obscure phenomena may have presented difficulties in the way of our investigations. "We need not be surprised," Mr Macleay observes in his *Horæ Entomologicæ*, "that several of the Linnæan algæ should be still hovering in a state of uncertainty between the two kingdoms; but, on the contrary, be prepared to expect additional proofs of the analogy which the two great divisions of organized matter bear to each other. The Agastria, or Agastraires of De Blainville, are indeed *animals*, though they have neither distinct organs of sense, alimentary canal, nor even mouth,—though they have, in short, so far as our present knowledge of them would lead us to believe, no internal digestion whatever to execute, but trust for nourishment, like plants, to the absorption of their external pores. They must be esteemed animals on account of their peculiar irritability; but are vegetables in almost every other respect."

Our knowledge of the history of animalcules resulted from the improvement of the microscope by Hartzoeker and Leeuwenhoeck. The ancients were consequently unacquainted with the mysteries of this "invisible world;" and we are thus saved the tedium of a lengthened bibliographical investigation. Notwithstanding the observations of Hill, Baker, Ledermuller, Goeze, Gleicken, Roësel, Pallas, Needham, Spallanzani, and several other minute and laborious inquirers, it may be said that this branch of zoology only assumed a truly scientific form in consequence of the labours of a distinguished Danish naturalist, Otho Frederic Müller. His earlier works, such as the *Vermium Terrestrium et Fluviatilium Historia*, and the *Zoologiæ Danicæ Prodromus*, presented very decided improvements in the knowledge and classification of animalcules. These emendations were transferred by Gmelin to the 13th edition of the *Systema Naturæ* of Linnæus, in which animalcules form the fifth order of the class of Vermes. But the work which, had the rest been wanting, would alone have immortalized the name of Müller, appeared (posthumously) in 1786, under the title of *Animalcula Infusoria, Fluviatilia et Marina*. It is illustrated by 50 plates, containing figures of 360 species variously represented. A later and very useful compendium of knowledge regarding microscopical animals forms a portion of the *Encyclopédie Méthodique* (46th livraison), in which Bruguière has reproduced the plates of Müller, with the addition of several others of equal accuracy from the third volume of Roësel's *Insecten-belustigungen*. The reader will there find descriptions of 28 plates, containing nearly 1100 figures representing 385 animalcular species.

Before proceeding further, we shall present a brief view of the system of Müller, as of high importance in itself, and the fundamental basis of the more recent and improved arrangements. It includes, however, several genera which are not now classed among the animalcular tribes. He divides the CLASS of ANIMALCULA INFUSORIA as follows:

ORDER I.—*No External Organs.*

* *Thickened.*

Genus 1. *Monas;* body punctiform. 10 species.
2. *Proteus;* body variable. 2 species.
3. *Volvox;* body spherical. 12 species.
4. *Enchelis;* body cylindrical. 27 species.
5. *Vibrio;* body elongated. 31 species.

* * *Membranous.*

6. *Cyclidium;* body oval. 10 species.
7. *Paramæcium;* body oblong. 5 species.
8. *Kolpoda;* body sinuous. 16 species.
9. *Gonium;* body angular. 5 species.
10. *Bursaria;* body excavated. 5 species.

ORDER II.—*External Organs.*

* *Naked.*

11. *Cercaria;* smooth, tailed. 22 species.
12. *Trichoda;* haired or ciliated. 89 species.
13. *Kerona;* with horny appendices. 14 species.
14. *Himantopus;* with cirrated appendices. 7 species.
15. *Leucophra;* the entire surface ciliated. 26 species.
16. *Vorticella;* orifice ciliated. 75 species.

* * *Furnished with a Shell.*

17. *Brachionus;* orifice ciliated. 22 species.

In the year 1815 Lamarck published the first part of his *Animaux sans Vertèbres*, a work which forms an epoch in the history of the inferior tribes. In this signal publication the author adopts a different course from that usually followed by systematic writers; and pursuing an ascending rather than a descending scale, he commences with the lowest and least complex species, viz. the Infusoria. From this class, however, he rejects all those species in which any kind of complication of organs is apparent. All the genera so distinguished are referred by him to the first order of the second class of the animal kingdom, called POLYPI, under the title of *Polypi ciliati;* and the true and restricted Infusoria are thus defined: *Microscopical animals, gelatinous, transparent, polymorphous, contractile; having no distinct mouth, nor constant, determinable, internal organs; generation fissiparous or sub-gemmiparous.* The genus Kerona, it may be further remarked, is in this system united to the Himantopus of Müller, while the genus Cercaria of that author is divided into two. Thus the class Infusoria of Lamarck, composed of two great sections, the naked and the appendiculated, may be said to correspond to the first 14 genera of the Danish naturalists.

Cuvier, in the *Règne Animal* (1817), places the Infusoria as a part of his fourth great division, the zoophytical or radiated animals. The term *radiated* was originally bestowed on a numerous tribe of animals, such as the Asterias and others, on account of their arms or tentacula being extended in a radiated or star-like form; but it certainly applies unfitly to the true Infusoria of Lamarck, which possess nothing resembling a radiated structure. It cannot, however, be always expected that a general term of wide import should apply with etymological accuracy to every part of the extensive series which it is intended to embrace. Cuvier then divides his Infusoria into two orders, *Les Rotifères*, and *Les Infusoires homogènes*, the former of which correspond to the ciliated polypi of La-

marck, the latter to the Infusoria properly so called of that author.

According to M. de Blainville, the class Infusoria can scarcely be regarded as established upon a natural foundation. The organization of its component tribes is so various as to lead to the belief that a more precise knowledge would show that several of those tribes belong to different types of the animal kingdom. Some, as the genus Brachionus, are symmetrically formed both as regards their bodies and appendages, and are protected by a horny or crustaceous covering. Others, as Vibrio, Paramæcium, &c. have the body elongated, depressed, vermiform, and without appendages. A third division exhibit a radiated structure, as for example the Vorticellæ, which, however, we have already stated, are now seldom classed among the Infusoria. Many genera, such as Proteus, Volvox, Monas, are amorphous, or without determinate form, and cannot be referred to any other known type of the animal kingdom. They are regarded by many as the elementary molecules of all animal life, and in their structure no other than the cellular tissue is observable. They may be said to be dependent on external circumstances, instead of being able, like other animals, to modify or control them; and their usually spherical form is the necessary result of an equal pressure of water on all sides of a frail and yielding texture. M. de Blainville considers the genera *Brachionus*, *Urcelaria*, *Cercaria*, *Furcularia*, *Kerona*, *Trichocerca*, and *Himantopus*, as belonging to the type of *Entomozoaires* or articulated animals, and especially to the class Heteropoda, order Entomostraca. Many species of *Vibrio* he regards as Apodes, as well as *Paramæcium* and *Kolpoda*. Other species of the genera *Vibrio* and *Cyclidium* ought rather to be ranged with the Planaria; and in the genus *Leucophra* there is even a species which M. de Blainville is inclined to look upon as an Ascidia! Finally, the genera *Gonium*, *Proteus*, *Volvox*, and *Monas*, if they are really animals, appear to form a distinct type, which may be called Amorphes or Agastraires; so named from the circumstance of their having neither determinate form nor reduplication of the external envelope for the formation of a stomach, as in all other true animals.

Such is a brief exposition of the views of one of the most distinguished physiological inquirers of the present day. It may serve, if for nothing more, at least to show the unsettled state of opinion concerning these extraordinary creatures. In regard to this, however, we may rest assured that, in the future progress of science, the class Infusoria, as at present constituted, will suffer an entire dismemberment, and its component parts will be referred to various groups of the animal kingdom, some of them widely distant from each other.

In the year 1826 a full and most elaborate classification of microscopical animals was given to the world by M. Bory de St Vincent. As it is the singular mode of existence of animalcular beings, their general economy in the field of nature, the actual conditions of their organization, and the state of their limited faculties so far as these can be ascertained, with which we are chiefly interested—so, in our systematic view of this extraordinary class, we shall merely present to our readers the characters of the principal genera, and of a few of the most remarkable species which they contain. But, as some may be desirous to possess at least a sketch of the full extent and condition of this intricate subject, we have constructed the accompanying tabular scheme of the orders, families, and genera of microscopical animals, according to the views of M. Bory de St Vincent, the latest and most assiduous writer on this department with whose labours we are acquainted. We have thought it advisable to retain the terms of the original language, lest, by inadvertence or misconception on the part of the translator, any additional obscurity should rise around a subject already sufficiently encumbered. (*See Tabular View on the next page.*)

The order Gymnodes of Bory de St Vincent nearly corresponds to the entire class Infusoria of Lamarck; and although the observations by which he illustrates his arrangement partake of the accustomed defects of the French philosophy, the facts which he details, if not the theoretical views which he inculcates, are worthy of an attentive consideration. These mysterious creatures are observed to swim with astonishing rapidity; and although their bodies are usually diaphanous, it has hitherto proved impossible, even by the aid of the most powerful glasses, to ascertain by what natural mechanism these movements are effected. They direct their courses by a discretionary power, in one direction rather than another, avoiding and turning round opposing obstacles, according to the necessities of the case—discerning, as the process of evaporation proceeds, the points in which they may prolong their existence, and flocking in crowds to those places where they are best screened from the overpowering brilliancy of the reflecting mirror. They thus appear to possess volition, which we are accustomed to regard as a result dependent on the faculties of perception and comparison.

The principal obstacle to our understanding the essential nature of animalcules results from their want of a nervous system, which, in ourselves, and in all the intermediate classes of the nature of whose consciousness we have even a vague idea, we regard as the *sine qua non* of sensation and intelligence. Voluntary motion without muscular action is also a circumstance which we cannot very clearly comprehend. But as there may be "more things in heaven and earth than are dream't of in our philosophy," we must not reject facts, that is to say appearances which present themselves under the same determinate and uniform aspect to various unprejudiced ob servers, merely because they do not coincide, or may possibly controvert or interfere, with a previous hypothesis. On the other hand, the extreme softness of texture, and excessive minuteness, of most of the animalcular species, render anatomical investigation almost impossible; and naturalists may have erred in supposing the absence of what they are merely unable to perceive and demonstrate.

It is in truth impossible to discover any traces of the nervous system, even among several tribes of animals in other respects much more highly organized than the subjects of our present inquiry. Trembley's examination of the Polypus threw no positive light upon the matter; nor did Gade's dissections of the larger Medusæ enable him to discover either muscular or nervous fibres. According to M. Bory de St Vincent, the nervous system is one of the last to be developed. To the perfect simplicity of the Monads, the first perceptible addition is that of a central cavity, or rudimentary intestinal sac, which we find to occur even before the existence of a mouth. Next appears an opening to this canal, which serves both for the reception of nourishment, and the rejection of excrementitious parts where such exist. The hairs and cirrated appendages which ensue in still more complicated species have been regarded as the early rudiments of the respiratory system; and even a heart, or central organ of a circulating fluid, is partly developed before the appearance of any nervous chords. The earliest, most general, and perhaps the only indispensable function of animal life, is that of nutrition. But the materials of nutrition are so different, and their modes of reception so various, that the exercise of this

Table of the Orders, Families, and Genera of Animalcules, according to a new Analytical Method. By Bory de Saint-Vincent.

MICROSCOPIQUES.

ORDRES. — FAMILLES. — GENRES.

- **Sans aucune apparence de test.**
  - **Parfaitement glabres, sans cils ni cirres vibratiles ... GYMNODÉS.**
    - Dépourvus d'appendices quelconques, soit caudiformes ou autres.
      - Jamais linéaires ni anguiformes.
        - De formes invariables.
          - Où chaque molécule est ou peut devenir un animal particulier.
            - Molécules toujours isolées, et formant autant d'individus ... **MONADAIRES.**
              - Corps anguleux, non arrondi ... 1. *Lamellina.*
              - Corps arrondi, jamais anguleux.
                - Sphérique.
                  - Sans point central ... 2. *Monas.*
                  - Marqué d'un point central ... 3. *Ophthalmopl*
                - Ovalaire comprimé ... 4. *Cyclidium.*
            - Molécules groupées, et comme formant un individu en commun ... **PANDORINÉES.**
              - Où les molécules groupées ne sont revetues d'aucune enveloppe commune.
                - Se groupant en sphérules ... 5. *Uvella.*
                - Se groupant en lames ... 6. *Pectoralina.*
              - Où les molécules groupées sont englobées dans une enveloppe commune ... 7. *Pandorina.*
          - Où les molécules demeurent irrévocablement asservies à une vie commune, et ne se désunissent jamais pour vivre isolément ... **VOLVOCIENS.**
            - Corps sphérique.
              - Où la molécule interne laisse un anneau translucide autour du corps ... 8. *Gyges.*
              - Où la molécule interne remplit le corps sans laisser comme un anneau translucide circulaire ... 9. *Volvox.*
            - Corps pyriforme ... 10. *Enchelis.*
        - De forme plus ou moins variable.
          - Corps applani et ne s'excavant jamais ... **KOLPODINÉES.**
            - Corps jamais plissé à sa surface.
              - Antérieurement denté ... 11. *Triodonta.*
              - Non denté antérieurement.
                - Sinueux ... 12. *Kolpoda.*
                - Amorphe ... 13. *Amiba.*
            - Corps muni d'un pli à sa surface ... 14. *Paramæcium.*
          - Corps excavé, ou susceptible de s'excaver ... **BURSARIÉES.**
            - Corps se creusant en bourse.
              - Dépourvu de cloison interne ... 15. *Burraria.*
              - Présentant un rudiment de cloison interne ... 16. *Hirundinella.*
            - Corps creusé en godet ... 17. *Craterina.*
      - Linéaires ou anguiformes ... **VIBRIONIDES.**
        - Corps opaque.
          - Roulé en spirale discoïde ... 18. *Spirilina.*
          - Non roulé en spirale discoïde ... 19. *Melanella.*
        - Corps diaphane.
          - Atténué aux deux extrémités ... 20. *Vibrio.*
          - Obtusé.
            - Atténué en cou, avec un bouton en manière de tête ... 21. *Lacrimatoria.*
            - Non atténué en cou, et sans bouton en manière de tête ... 22. *Pupella.*
    - Munis d'un ou de deux appendices caudiformes ou autres.
      - Normaux.
        - Un seul appendice caudiforme terminal ... **CERCARIÉES.**
          - Corps cylindracé.
            - Polimorphes ou du moins contractiles.
              - Où l'appendice est une continuation du corps graduellement aminci ... 23. *Raphanella.*
              - Où l'appendice est comme implanté en queue ... 24. *Histrionella.*
            - Non contractiles ni polymorphes.
              - Sans carène sur aucun coté du corps ... 25. *Cercaria.*
              - Corps présentant une carène sur un de ses cotés ... 26. *Turbinella.*
          - Corps comprimé.
            - Point d'appendices latéraux.
              - Appendice caudal non infléchi sur un côté du corps ... 27. *Zoosperma.*
              - Appendice caudal infléchi sur un côté du corps ... 28. *Virgulina.*
            - Deux petits appendices latéraux outre le caudiforme ... 29. *Tripos.*
        - Appendice double ou bifide ... **URODIÉES.**
          - Corps non vaginiforme, ni distinctement urcéolé.
            - Non terminé en une sorte de tete.
              - Les deux appendices distincts jusqu'à leur insertion.
                - Continus avec le corps, et non infléchis ... 30. *Furcocerca.*
                - Comme implantés au corps, et infléchis ... 31. *Trichocerca.*
              - Les deux appendices se fourchant sur un pédicule et non sur le corps ... 32. *Ty.*
            - Se terminant en une sorte de tete ... 33. *Cephalodella.*
          - Corps subvaginiforme ou urcéolé.
            - Appendices terminaux ... 34. *Leiodina.*
            - Appendices latéraux ... 35. *Kerobalana.*
      - Genre anomal; appendices en forme de herse épars sur l'une des surfaces de l'animal ... 36. *Tribulina.*
  - **Où se distinguent des cils ou des cirres vibratiles.**
    - **Où des cils répandus sur toute la surface du corps, ou disposés diversement sur quelqu'une de ses parties, ne forment point d'organe vibratile particulier, et encore moins de rotatoires complets ... TRICHODÉS.**
      - Corps totalement dépourvu d'appendices caudiformes ou autres.
        - Où les cils couvrent ou environnent la totalité du corps ... **POLYTRIQUÉES.**
          - Velus.
            - Corps ni fissé, ni appendiculé ... 37. *Leucophra.*
            - Corps fissé, ou appendiculé à l'une des extrémités ... 38. *Diceratella.*
          - Ciliés.
            - Corps non antérieurement atténué en cou ... 39. *Peritricha.*
            - Corps antérieurement atténué en cou ... 40. *Stravolæma.*
        - Où les cils, ne couvrant pas ou n'environnant pas la totalité du corps, y sont répartis en faisceaux ou séries ... **MYSTACINÉES.**
          - Cils en un seul faisceau ou série.
            - En un faisceau terminal.
              - Corps antérieurement atténué en cou que termine un bouton en maniere de tete ... 41. *Phialina.*
              - Corps non antérieurement atténué en cou, et que ne termine aucun bouton ... 42. *Trichoda.*
            - En une série latérale.
              - Corps sub-urcéolé ... 43. *Ypsistoma.*
              - Corps jamais sub-urcéolé ... 44. *Plagiotricha.*
          - Cils en plus d'un faisceau ou série.
            - Corps antérieurement fissé, ou les cils forment comme deux moustaches ... 45. *Mystacodella.*
            - Corps non antérieurement fissé.
              - Sans apparence d'ouverture buccale que bordent les cils.
                - Cils de meme nature, dont les uns ne sont ni plus longs ni plus rigides que les autres.
                  - En deux groupes.
                    - Sérialement ... 46. *Oxytricha.*
                    - Fasciculés ... 47. *Ophrydia.*
                  - En trois groupes ... 48. *Trinella.*
                - Cils de diverse nature, dont les uns sont plus longs ou plus rigides que les autres ... 49. *Kerona.*
              - Avec une sorte d'ouverture buccale sur un coté que bordent les cils ... 50. *Kondyliostoma*
      - Corps terminé en appendices caudiformes ... **URODÉES.**
        - Appendice caudal simple ... 51. *Ratulus.*
        - Appendice caudal double ... 52. *Diurella.*
    - **Ou les cirres vibratiles, disposés sur les bords ou aux alentours d'un orifice buccal, deviennent vivement vibratiles.**
      - **Où les cirres vibratiles ne forment pas de rotatoires complets distincts ... STOMOBLÉPHARÉS.**
        - Corps urcéolé ... **URCEOLARIÉES.**
          - Corps non contractile ni polymorphe ... 53. *Myrtilina.*
          - Corps contractile, plus ou moins polymorphe.
            - Vaguant, et non stipité.
              - Urcéole rempli par un corps qui se prolonge centralement en mammelon ... 54. *Rinella.*
              - Urcéole entièrement évidé.
                - Postérieurement épais, obtus et non atténué ... 55. *Urceolaria.*
                - Postérieurement atténué en pointe, et tubiforme ... 56. *Stentorina.*
            - Stipité, et se fixant ... 57. *Sinantherina.*
        - Corps vaginé ... **THIKIDÉES.**
          - Corps fixé dans le fourreau.
            - Appendice caudal simple.
              - Deux filamens tentaculaires antérieurs ... 58. *Filina.*
              - Point de filets tentaculaires quelconques ... 59. *Monocerca.*
            - Appendice caudal composé.
              - Bifide ... 60. *Furcularia.*
              - Trifide ... 61. *Trichocerca.*
          - Corps libre et non adhérant dans le fourreau ... 62. *Vaginicola.*
      - **Où les cirres vibratiles forment des rotatoires complets et distincts ... ROTIFERES.** ... (Cet Ordre ne contient qu'une famille) ... **ROTIFÈRES.**
        - Corps contenu dans une capsule en ampoule où il semble ne pas adhérer.
          - Rotatoires non variables, constamment doubles.
            - Sessiles ... 63. *Foliculina.*
            - Pédicellés ... 64. *Bakerina.*
          - Rotatoire variable d'un à quatre lobes ... 65. *Tubicolaria.*
        - Corps non contenu dans une capsule en ampoule.
          - Corps non vaginé, rotatoire bilobé ... 66. *Megalotrocha.*
          - Corps vaginé, rotatoires complètement distincts ... 67. *Ezechielina.*
- **Corps protégé par un test ... CRUSTODÉS.**
  - Munis d'appendices, soit en queue, soit en cornes, et postérieurs.
    - Munis de cirres vibratiles ... **BRACHIONIDES.**
      - Cirres vibratiles formant des rotatoires complets.
        - Test capsulaire urcéolé.
          - Corps terminé par une queue.
            - Bifide ... 68. *Brachionus.*
            - Simple ... 69. *Siliquella.*
          - Sans queue ... 70. *Keratella.*
        - Test univalve en carapace.
          - Queue bifide terminale ... 71. *Tricalama.*
          - Queue non bifide, sub-centrale ... 72. *Proboskidia.*
      - Cirres vibratiles ne formant que de simples faisceaux.
        - Test non urcéolé.
          - Univalve.
            - Queue sub-centrale ... 73. *Testudinella.*
            - Queue terminale ... 74. *Lepadella.*
          - Bivalve ... 75. *Mytilina.*
        - Test urcéolé ... 76. *Squatinella.*
    - Dépourvus de cirres vibratiles ... **GYMNOSTOMÉES.**
      - Test capsulaire urcéolé ... 77. *Silurella.*
      - Test non capsulaire.
        - Bivalve ... 78. *Colurella.*
        - Univalve ... 79. *Squamella.*
  - Dépourvus de tout appendice postérieur quelconque ... **CITHAROIDÉES.**
    - Des cirres à la partie antérieure seulement ... 80. *Anourella.*
    - Des cirres aux deux extrémités antérieure et postérieure.
      - Nageant le coté convexe du test en dessous, comme un bateau ... 81. *Plœsconia.*
      - Nageant le coté convexe en dessus, comme une tortue ... 82. *Coccudina.*

function by no means necessitates the existence of a mouth, a stomach, or an alimentary canal; for an increase of parts may be effected even through the medium of imponderable or elastic fluids, and by imperceptible and superficial pores.

The exterior of an infusory animal may be compared to the interior of one of the higher classes, in which nutrition is carried on by the reception of the chyle by the absorbent pores. These pores are external among the Infusoria, and the process of absorption is with them analogous to that of plants, in which there is a direct reception and appropriation of fluids from the earth and air, without any previous preparation in a central cavity or stomach. Zoophytes in general have indeed been called the cryptogamia of the animal kingdom. According to Carus, the Infusoria ought to be regarded merely as little cells, partially filled with lymph, and possessed of the powers of nutrition and locomotion; and thus the infinite changes and variations perceptible in their forms may be supposed to be produced by the various degrees in which this fluid is collected at one or other of the points of their bodies. In the opinion of that anatomist, a more complete developement of the organs of motion, and indeed of the whole organization, is inseparably united with the appearance of a distinct nervous system. This may be true as a general rule, but not as a universal principle; for the Medusa has more apparent voluntary motion than the Asterias, though the former is destitute of those nerves which in the latter make their first appearance in the shape of a pale thread-like ring surrounding the œsophagus. It is this ring around the upper extremity of the alimentary canal which, in the molluscous and articulated classes, we shall afterwards find to constitute the most uniform and most essential portion of the nervous system. The Medusæ, just referred to, being almost of the same specific gravity with water, are easily carried by currents, and moved about from place to place by the action of the waves, or even (as in the case of *Holothuria physalis*) by the winds; but Carus and other writers have assuredly erred in doubting that they execute a voluntary locomotion; for that they do so in a very decided and graceful manner must be obvious to all who have attended to these animals in their native haunts along the shores, or among the land-locked waters of the beautiful firths of Scotland.

The mysteries revealed by the glasses of Leeuwenhoeck were at first regarded as beyond belief. The uncertainty of microscopical investigations, in consequence of which so much was supposed to depend on the imagination of the beholder, was alleged against them; and even at an after-period, when men of sober judgment and the most industrious application had confirmed the experience of the indefatigable Dutchman, the wit of Voltaire did not disdain to throw its cutting sarcasm over the disciples of the "anguilles de la pâte et du vinaigre." We hope it is now admitted, that however frequently those who endeavour to expound the mysteries of nature may fail in their attempts at elucidation, yet that there is nothing in the manifold works of Omnipotent Wisdom which, if duly studied and rightly understood, would not conduce to our wellbeing and happiness; and that a single square inch of water, with its many millions of animalcular atoms, is in truth as wonderful a work of divine intelligence, and as interesting a field for human investigation, as the starry galaxy of heaven.

> In his tam parvis, atque tam nullis, quæ ratio!
> Quanta vis! quam inextricabilis perfectio!

And if a heathen philosopher (Pliny) has so expressed his almost reverential admiration, is it not to be deplored that those whose labours might be carried on under the influence of a purer light, seem as often degraded as exalted by the contemplation of their Creator's works; and, referring all to the powers of nature, or some other indefinite abstraction, refuse to recognise, amid so many wonders, the "Good Supreme" from whom these and other mightier wonders have proceeded? It is in the study of the subject with which we are now engaged, and the analogous pursuits of physiology, where the completion of the most perfect design and the happiest results of superhuman forethought are so constantly manifested, that we frequently meet, where we should least expect it, with the sneer of the sceptic, or the impious ridicule of the unbeliever. How different are the sentiments of one who combines the piety of the Christian with the genius of the poet and philosopher. "But about the time of its invention (the invention of the telescope), another instrument was formed, which laid open a scene no less wonderful, and rewarded the inquisitive spirit of man with a discovery which serves to neutralize the whole of this argument. This was the microscope. The one led me to see a system in every star; the other leads me to see a world in every atom. The one taught me that this mighty globe, with the whole burden of its people and of its countries, is but a grain of sand on the high field of immensity; the other teaches me that every grain of sand may harbour within it the tribes and the families of a busy population. The one told me of the insignificance of the world I tread upon; the other redeems it from all its insignificance; for it tells me, that in the leaves of every forest, and in the flowers of every garden, and in the waters of every rivulet, there are worlds teeming with life, and numberless as are the glories of the firmament. The one has suggested to me, that beyond and above all that is visible to man, there may lie fields of creation which sweep immeasurably along, and carry the impress of the Almighty's hand to the remotest scenes of the universe; the other suggests to me, that within and beneath all that minuteness which the aided eye of man has been able to explore, there may be a region of invisibles; and that, could we draw aside the mysterious curtain which shrouds it from our senses, we might then see a theatre of as many wonders as astronomy has unfolded, a universe within the compass of a point so small as to elude all the powers of the microscope, but where the wonder-working God finds room for the exercise of all his attributes, where he can raise another mechanism of worlds, and fill and animate them all with the evidence of his glory."[1]

Although we cannot hope to derive the same amusement or advantage from the study of each of the animalcular species considered separately, as we do from the consideration of the history of many of the higher animals, yet, in a philosophical point of view, a knowledge of the general attributes of the class presents several highly important objects; and their obscure origin, their singular organization, and more singular mode of existence, cannot fail to excite our unfeigned wonder and admiration. They can scarcely be described otherwise than by a negation of all those characters which constitute the life, power, and activity of other beings; they have no head, no eyes, no muscles, no blood-vessels, no nerves, no determinate organs for respiration, generation, or digestion—and yet they are endowed with life.

The animal nature of the Infusoria has indeed been denied by many; but such is the regular gradation from the most simply organized of the monadal forms to the much

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[1] Chalmers's *Astronomical Discourses*. p. 112

more complicated structure of the Polypi, which present, under a remarkable aspect, such unequivocal characters of animality, that it is impossible to draw the line of demarcation; and if we admit the life of the one we can scarcely doubt that of the other. Yet many of the Infusoria appear to present the very lowest conceivable point to which animal life can be reduced.

The structure of an animal, the individual existence of which is preserved by the absorption of a circumambient fluid, and the continuance of whose species is effected by the division or separation of a part of its own body, might, *a priori*, be supposed to be of the most simple kind. "We may rest assured," observes Lamarck, "that whenever an organic function is itself unnecessary, the special organ by which it is usually performed will not be found to exist." It is indeed by considering the nature of the Infusoria that we are enabled to form a proper idea of the simplest condition of animal life; and the invention of the telescope was not of higher importance to the astronomer, than that of the microscope to the physiological naturalist. There are few subjects of reflection more interesting than the uses which philosophers of an enlightened age have deduced and matured from the scanty knowledge of a barbarous people. Glass, a material known at an early period to the Asiatic nations, and once estimated at its weight in gold, has become in the hands of Europeans of more value than the finest gold. Whoever polished the first lens may be said to have laid the foundation of an instrument destined to discover thousands of celestial worlds above and around us, and an unseen world of wonders beneath our feet. "Indeed," says Cuvier, "it could not be expected that those Phœnician sailors who saw the sand of the shores of Bœtica transformed by fire into a transparent glass, should have at once foreseen that this new substance would prolong the pleasures of sight to the old; that it would one day assist the astronomer in penetrating the depths of the heavens, and in numbering the stars of the milky way; that it would lay open to the naturalist a miniature world as populous, as rich in wonders, as that which alone seemed to have been granted to his senses and his contemplation; in fine, that the most simple and direct use of it would enable the inhabitants of the coast of the Baltic Sea to build palaces more magnificent than those of Tyre and Memphis, and to cultivate, almost under the frost of the polar circle, the most delicious fruits of the torrid zone."[1]

The faculties of the most simple infusory animals, it has been observed, are reduced to such as are common to all living beings, and to that *irritability* which results from their animal nature; and their bodies are destitute of special organs, precisely because their extremely limited faculties neither require nor admit of such organs being exercised. The chief interest to be derived from the study of this class of beings results, according to Lamarck, from the view with which such study presents us of the ultimate point to which the organization of an animal is capable of being reduced; and, among all the wonders of the creation, he regards as the most surprising the existence of animal life in such inconceivably frail and simple bodies as the least complicated of the animalcular species. It is not, however, to be said that "nature was incapable of forming special organs from the materials of these frail gelatinous bodies," but rather that the all-wise Author and Ruler of Nature has seen fit to form them in what to us may appear a destitute and incomplete condition, merely because their structure does not fulfil those other conditions which, erroneously, we have sought to establish as the indispensable bases of animal life. They truly show how confined a knowledge *our* limited faculties enable us to gain of His unlimited power; for they not only present no analogy to other more accustomed forms of life, but almost seem to exist in direct opposition to those laws in accordance with which we "live, move, and have our being."

Infusory animals, commonly so called, are found in the fresh and saline waters of all countries. They occur both naturally, if we may use the term in a contradistinctive sense, and as the apparent result of infused animal and vegetable substances. According to Leeuwenhoeck, the milt of a cod-fish contains more animalcules than there are individuals of the human race existing on the face of the earth; and he calculated that 10,000 might be held within the bulk of a grain of sand. The size of many bears the same relation to that of a mite as the dimensions of a bee do to those of an elephant; and the most powerful microscopes frequently discover nothing more than merely perceptible points in motion. Flour and water made to the consistence of book-binders' paste, exposed in an open vessel, and frequently stirred to prevent the surface from growing hard, will in a few days be found to contain millions of animalcules. The thin pellicle which grows on the surface of an infusion of common black pepper also produces an innumerable congregation of minute beings. Of these and others the real origin is still exceedingly obscure; and both Müller and Spallanzani maintained the improbable opinion that they fell from the air. Their subsequent increase or multiplication is obviously effected in different and very singular ways. Such as are spherical are usually propagated by minute portions, which, though they burst from the anterior of the animalcule itself, cannot be called eggs; and such as are of a depressed or flattened form continue their race by *cuttings* or divisions of their own bodies. We first observe a line or groove, longitudinal or transverse, according to the species; and ere long a notch or incision is perceptible at one or other or both of the ends of that apparent line. This notch increases across or longitudinally, till at last a portion is separated or cut off, or the original animal is divided into two, and each assumes the form and nature of their mutual predecessor. These new objects retain for some time their natural shape, and then in their turn give rise to one or more individuals by a similar separation of parts. Lamarck seems to be of opinion (*Philosophie Zoologique*, tome ii. p. 120 and 150) that this multiplication by division, and that by the emission of gemmules or oviform portions, are modifications of one and the same natural process;—that substantially each is the result of an extension and separation of parts, which take place when the parent individual has reached the final term of its increase. It is in fact the same excess of nourishment and growth of particular parts that, even in the higher classes, give rise to the germ of separate life, physically considered, although in regard to these the additional process of fecundation is required. It is the new light which may be gathered from the observation of the minutest of the animalcular tribes that renders their study both interesting and important to the physiologist; and it is the belief of some, that a persevering study of the history of microscopical animals will one day enable us to withdraw the mysterious veil which still conceals from our view the most important secrets of nature.

The systematic arrangement of animalcules which we propose to follow in this place is nearly that of Lamarck,

[1] *Réflexions sur la Marche actuelle des Sciences*, &c. read to the Institute of France in April 1816.

which is itself founded on the systems of Müller and Bruguière. The French naturalist includes in his system only such species of the same class described by Müller as are destitute of a mouth.

ORDER I.—NAKED INFUSORIA.

Body extremely simple, apparently homogeneous, unprovided with organs or external appendages.

The naked Infusoria are the smallest and simplest of those animals which are cognizable by the senses of man. When we expose water to air and light, especially if it contains an infusion of animal or vegetable remains, we speedily perceive, by the assistance of the microscope, a variety of animalcules. These are divided into two sections.

SECTION I.—BODY THICK.

Of this section the bodies present such a perceptible degree of thickness as removes them from the simply membranous state.

GENUS MONAS.—Body extremely small, of the simplest construction, transparent, punctiform.

The Monads are the smallest and least organized of living creatures. We have indeed scarcely any proof of their animal life, except that they are moving corpuscles, allied to the genus Volvox, the animality of which is undoubted. They have neither mouth nor alimentary canal, nor any apparent organs. They live by absorption, and are found in tranquil, but rarely in limpid waters. They are produced in infusions of animal and vegetable substances.

Sp. 1. *Monas termo.*—An extremely minute gelatinous point, scarcely perceptible even with the aid of a powerful lens, and frequently disappearing under a strong light in consequence of its perfect transparency. This species is common in ditch-water, and in numerous infusions. See Plate XLII. fig. 1. These minute creatures being the earliest discernible evidence of animal life, and the last result to which the higher and more perfect forms can be reduced by infusion, have been called the alpha and omega of all organized existence. Their history has given rise to many curious views, and more absurd speculations.

Sp. 2. *Monas atomus.*—White, with a variable dark-coloured spot, which appears to change its position. This species was found in sea-water which had been kept an entire winter, but was not very fetid. See Plate XLII. fig. 2 and 3.

Sp. 3. *Monas punctum.*—Nearly black, of a sub-cylindrical form. Found in the infusion of the pulp of a pear.

Sp. 4. *Monas lens.*—Hyaline, of an ovoid form. Found in all kinds of waters. Multiplies by spontaneous incision.

Sp. 5. *Monas pulvisculus.*—Hyaline, with a greenish margin. Found in the waters of marshes. This species has been lately regarded as an *enchelis*. Indeed, so great is the difficulty of microscopical investigation, and such indefatigable patience is required in order to see things as they really are, that the species and genera of this class of beings are frequently transposed and altered in their relative position and arrangement, in consequence of the very dissimilar views which different observers have taken of the same object.

As it would be inconsistent with our present limits to describe more than a few species of each genus, we shall content ourselves with the preceding Monads. "How many kinds," observes Mr Adams, "there may be of these invisibles, is yet unknown, as they are discerned of all sizes, from those which are barely invisible to the naked eye, to such as resist the force of the microscope, as the fixed stars do that of the telescope, and, with the greatest powers hitherto invented, appear only as so many moving points."

GENUS VOLVOX.—Body very simple, transparent, spherical or ovoid, revolving on itself as on an axis.

With the exception of one species (*V. globator*) the volvoces are invisible to the naked eye. Under the microscope they assume the aspect of small gelatinous masses, which sometimes present an oval form. In some the body seems composed of numerous smaller globules united in one common mass. There is reason to suppose that these interior bodies are afterwards propelled outwardly, and become separate individuals. The species occur both in fresh and salt waters, and in vegetable infusions. They derive their generic name from the manner in which they turn or revolve upon their axis. Leeuwenhoeck describes an animalcule "a thousand times smaller than a louse's eye, which exceeded all the rest in briskness," and turned itself round as it were upon a point, with the celerity of a spinning-top. The genus is divisible into two sections.

* *Interior of the body apparently simple and homogeneous.*

Sp. 1. *Volvox punctum.*—Spherical, blackish, with a central lucid point. Of this species many are sometimes seen together in their passage through the water. They occasionally move as if subjected to the influence of a whirlpool, and then separate. Numerous in fetid sea-water.

Sp. 2. *Volvox granulum.*—Spherical, green, periphery hyaline. Dwells in the water of marshes.

Sp. 3. *Volvox globulus.*—Globular, sub-obscure behind. This species is ten times larger than the Monas lens. It occurs in most vegetable infusions, and moves with a slow fluttering motion. Plate XLII. fig. 4.

** *Interior of the body exhibiting smaller corpuscles.*

Sp. 4. *Volvox pilula.*—Spherical, with greenish internal globules. In those pure waters which nourish the *Lemna minor*. Plate XLII. fig. 5.

Sp. 5. *Volvox lunula.*—Roundish and transparent, and composed of an innumerable assemblage of homogeneous crescent-shaped molecules, without any common margin. Its movements are of two kinds, that of the molecules among themselves, and that of the whole revolving mass. It occurs in marshy places in the early spring. Plate XLII. fig. 6.

Sp. 6. *Volvox globator.*—Commonly called the globe-animal. Spherical, membranous, the internal globules distant or scattered. Abundant in the infusions of hemp and tremella, and in stagnant pools during spring and summer. The following is an account of it by Mr Baker. "There is no appearance of either head, tail, or fins, and yet it moves in every direction, backwards, forwards, up or down, rolling over and over like a bowl, spinning horizontally like a top, or gliding along smoothly without turning itself at all; sometimes its motions are very slow, sometimes very swift; and, when it pleases, it can turn round as upon an axis very nimbly, without moving out of its place. The body is transparent, except where the circular spots are placed, which are probably its young." Another authority states that this species is at first very small, but increases to such a size that it may be discerned by the naked eye, and that its interior is filled with small globules, which are smaller animalcules, each of which contains within itself a still smaller generation, all perceptible by means of powerful glasses. The lesser globules may be seen escaping from the parent, and increasing in size.

Genus Proteus.—Body very small, simple, transparent, of varying form, changing itself instantaneously into different lobated shapes.

This genus is more obviously contractile than the preceding. It is seldom seen above a minute under the same form, but is continually passing from a simple oval or oblong to an irregular or sinuated shape, and *vice versa*. A species described by Roësel is so remarkable for this faculty, that it has been compared to a drop of water thrown upon oil. Hence also the generic name.

Sp. 1. *Proteus diffluens*.—Body diverging into branches. Occurs in the water of marshes. Plate XLII. fig. 7, 8, and 9.

Sp. 2. *Proteus tenax*.—Body prolonged to a fine point. Occurs in rivers and in sea-water. There are only two species described as belonging to this genus.

Genus Enchelis.—Body very small, simple, oblong, cylindrical, slightly variable.

There is a marked analogy between this genus and the following. The Enchelides are, however, short and thick compared with the Vibriones, which are slender and lengthened. To the genus now under consideration belong those animals which, if the recorded observations on the subject have been accurately made and faithfully reported, more than any other confound our preconceived ideas regarding the distinction between animal and vegetable life. The species alluded to are named *Zoocarpes* by M. Bory de St Vincent, or animated seeds, which appear reciprocally to give rise to and proceed from certain aquatic plants of the confervæ kind. They are formed in a bulbous-shaped part or swelling of the plant, are ejected when ripe, swim about for some time with a voluntary motion, throw out a root and a branch, become genuine vegetables, produce living seeds, and give birth to animals which, after a similar change of form, speedily return again to the vegetable state. These facts are vouched for by M. Bory de St Vincent, and are credited and confirmed by M. Dutrochet and several other continental inquirers, some of whom declare that they kept so watchful an eye upon the same individual as never to lose sight of it for a moment till they had witnessed the singular transformation above mentioned. We recommend it to our readers' consideration.

Sp. 1. *Enchelis viridis*.—Subcylindrical, obliquely truncated anteriorly. This species has an obtuse tail or terminal part. It continually varies its motion, turning from right to left. Occurs in long-kept water.

Sp. 2. *Enchelis punctifera*.—Subcylindrical, green, obtuse anteriorly, pointed posteriorly. This species is opaque, with a small pellucid spot in the fore part, in which two black points are seen, and a kind of double band crosses the middle of the body. It occurs in marshes. Plate XLII. fig. 10, 11.

Sp. 3. *Enchelis pulvisculus*.—This species bears a great resemblance to the *Monas pulvisculus* of Müller, which is the *E. monadina* of Bory de St Vincent. It is, however, double the size, deeper tinted, and more ovoid. It is found in the waters of marshes, and accumulates around the sides of jars or vases in which confervæ have been kept. It forms on the surface of water a slight pellicle of a delicate green colour, which is supposed to have been erroneously regarded by many botanists as a vegetable production, and described under the name of *Byssus flos aquæ*. On dying it becomes more lengthened and pellucid, or at least retains only a slight central spot of green. Plate XLII. fig. 12.

Sp. 4. *Enchelis amœna*.—This is a new species, of a lively green colour, discovered by Bory de St Vincent. In swimming it appears to elongate itself, and advances with the more slender end foremost. Two individuals are sometimes observed to unite and form one animal, of a perfectly spherical form, and similar in aspect to a Volvox.

Sp. 5. *Enchelis tiresias*.—This species was also discovered by the above-named writer, and led to his peculiar views regarding those apparently animated seeds which he has named *Zoocarpes*. He asserts that he has seen this animalcule formed in the articulations of a true conferva; that it burst from its vegetable envelope with a gyration or circular movement; that it soon produced a translucent prolongation of its body, which may be called anterior, as it then swam in the direction of that new organ, which, with the body itself, became visibly longer, till the creature finally acquired the exact form of the *Enchelis deses* of Müller. The chief difference seemed to be that it always moved with the slender end foremost, whereas the species just mentioned swims with its blunt end in advance. It is described by recent French writers as an " animal extraordinaire qui n'est certainement que la grain vivante d'un végétal." (See *Dict. Class. d'Hist. Nat.* tome vi. p. 156.)

Sp. 6. *Enchelis deses*.—This species is of an obscure green, much elongated, and moves with the thick end anteriorly. " Celui-ci (the obtuse portion) paraît comme tronqué dans certains aspects; et en examinant attentivement cette sorte de troncature, on la réconnaît formée par un cercle en forme de disque moins foncé que le reste de l'animal. La pointe postérieure est parfaitement hyaline. Dans la pensée où nous sommes que les Enchelides vertes ne sont que des Zoocarpes, ou propagules animés de quelques genres d'Arthrodiées, nous croyons que le disque obscurément transparent de la partie antérieure n'est que la marque du point sur lequel doit se développer l'article par lequel doit s'allonger en filament confervoïde le Zoocarpe, lorsque, arrivé au terme de sa carrière animale, il doit se fixer et prendre racine par le point hyalin de la partie postérieure." (*Loc. cit.* p. 157.) We present the above passage to our readers without note or comment, as we do not ourselves understand the zoocarpal nature of an Enchelis.

Genus Vibrio.—Body very small, simple, cylindrical, elongated.

Animalcules have been described as constituents of this genus, which probably do not at all belong to it, being too complicated in their structure. If the *V. aceti*, for example, commonly called the vinegar eel, is furnished with a mouth, lips, and alimentary canal, it does not even pertain to the class Infusoria, however small its dimensions. But many of the species are undoubtedly of the simplest construction; and although they may present some appearance of an internal cavity or sac, they yet exhibit neither mouth nor other external orifice of any kind.

Sp. 1. *Vibrio lineola*.—Body linear, extremely minute. Occurs in many vegetable infusions in such numbers as apparently to occupy their entire space. It is so small, that with the best magnifiers little more can be discerned than an obscure tremulous motion. It is supposed to exceed even the *Monas termo* in tenuity. Plate XLII. fig. 13.

Sp. 2. *Vibrio spirillum*.—Filiform, and twisted spirally, which seems to be its natural shape, as it is never observed to unbend, but moves forwards with a vibratory motion at both ends. Found in an infusion of *Sonchus arvensis*. Plate XLII. fig. 14.

Sp. 3. *Vibrio vermiculus*.—Presents a milky aspect, with a blunt apex, and moves with a languid vermicular motion. It has been found in marshy water in November, but is seldom seen. It agrees with the animal mentioned by Leeuwenhoeck as occurring in the dung of frogs.

Sp. 4. *Vibrio paxillifer*.—" Animalculum," says Mül-

ler, "vel congeries animalculorum mirabilis. Pluries in guttulis aquæ marinæ vidi corpuscula linearia flavescentia (solitaria paleas, in quadrangula disposita scobes referebant), granulaque seminalia qualiscunque vegetabilis diu credidi; demum nocte inter 6 et 7 Octobrem 1781 aspectu fili flavescentis, sese in longum producentis et in breve contrahentis, ac ex his paxillis compositi, obstupefactus, novoque phænomeno gavisus, ejusdem variis evolutionibus incubui." A salt-water species, abundant in ulva latissima. Observed during the months of September and October. Plate XLII. fig. 15, 16, 17, 18, 19.

Sp. 5. *Vibrio serpens.*—Slender and gelatinous, with obtuse windings or flexures, resembling a serpentine line. It is rare, and occurs in river-water.

Section II.—Body Membranaceous.

Of scarcely perceptible thickness, whether flat or concave.

The organization of the animalcules of this section is scarcely less simple than that of the preceding; but their form, being in a small degree resistant, is less subject to variation from the pressure or other action of the surrounding fluids, which has been regarded as the proof of a certain progress or advance in the scale of structure.

Genus Gonium.—Body very small and simple, flattened, short, angular. Some species of this genus appear to be composed of several corpuscles united together under a common membrane. This appearance probably results from their cellular tissue, or from certain lines which are the rudiments of those spontaneous divisions formerly mentioned, by which their propagation is affected. Their movements are oscillatory.

Sp. 1. *Gonium pectorale.*—Quadrangular and pellucid, with sixteen globules of a greenish colour set in a quadrangular membrane, "like jewels in the breast-plate of the high-priest, reflecting light on both sides." Occurs in pure waters. Plate XLII. fig. 20.

Sp. 2. *Gonium pulvinatum.*—Quadrangular and opaque. Found in dunghills.

Sp. 3. *Gonium corrugatum.*—Sub-quadrangular, whitish, marked by a longitudinal line. This species is found in various infusions, particularly that of the pear.

Sp. 4. *Gonium truncatum.*—Internal molecules dark green. Anterior extremity forming a straight line, with which the sides produce an obtuse angle, terminated posteriorly by a curved line. This species exhibits a languid motion. It is much larger than the preceding, and occurs, though rarely, in pure water.

Genus Cyclidium.—Body very small and simple, transparent, flattened, orbicular or oval.

The motions of this genus are oscillatory, circulatory, or demi-circulatory, more or less interrupted, and languid or lively, according to the species.

Sp. 1. *Cyclidium bulla.*—Orbicular and hyaline. General appearance pale and pellucid, with the edges somewhat darker than the rest. It moves slowly in a semicircular direction, and occurs in the infusion of hay.

Sp. 2. *Cyclidium hyalinum.*—Oval, depressed, perfectly transparent, terminated by a tail-like elongation. This species is very common, and is produced in many infusions, particularly in those of the cerealia. It swims in a vacillating manner, and as if continually trembling. Plate XLII. fig. 21.

Sp. 3. *Cyclidium Nucleus.*—Of a brownish tinge, deeper behind, and shaped exactly like an apple pippin.

Genus Paramæcium.—Body very small, simple, transparent, membranous, oblong.

The species of this genus, according to Lamarck, scarcely differ from those of the preceding, except in their more lengthened forms and a slight increase of animal development. They appear to vary instantaneously according to their position in relation to the eye of the observer; but their real form is tolerably determinate. The mode of increasing the species by transverse and longitudinal divisions, or natural cuttings, is very obvious in this genus. They are nearly related to the following, but are less sinuous and irregular. Their movements are for the most part slow and indefinite. They swim horizontally on one of their flattened surfaces, after the manner of flounders.

Sp. 1. *Paramæcium aurelia.*—Body compressed, with a kind of plait or fold towards the apex, acute behind. Very common in water where confervæ grow. Plate XLII. fig. 22, 23, 24.

Sp. 2. *Paramæcium chrysalis.*—Plicated anteriorly, obtuse behind. Occurs during the autumn in sea-water.

Sp. 3. *Paramæcium versutum.*—Cylindrical, thickened posteriorly, obtuse at both ends. Found in ditches.

Genus Kolpoda.—Body very small, simple, flattened, oblong, sinuous, irregular, transparent.

This genus is nearly allied to the preceding, and differs from it chiefly in its more varied forms. It is also less subject to the influence of pressure by the medium in which it lives. An Italian naturalist of the name of Losana has lately published a monograph on Kolpoda; but his figures are somewhat exaggerated, and not very naturally expressed.

Sp. 1. *Kolpoda lamella.*—Elongated, membranaceous, curved anteriorly. This species is seldom met with. It has a singular vacillatory mode of movement, and advances on its sharp edge, instead of its flattened side, the more usual position.

Sp. 2. *Kolpoda gallinula.*—Oblong, the anterior portion of the back membranaceous and hyaline. In corrupted sea-water.

Sp. 3. *Kolpoda crassa.*—Yellow, thickish, somewhat opaque, curved a little in the centre, kidney-shaped. This species has a quick vacillatory motion, and becomes apparent in the infusion of hay generally in about 13 hours. When the water is nearly evaporated it assumes an oval form, becomes compressed, and bursts.

Sp. 4. *Kolpoda rostrum.*—Oblong, hooked anteriorly. The movements of this species are slow and horizontal. It is found, but not frequently, in water where the lemna grows.

Sp. 5. *Kolpoda cucullus.*—Ovate, ventricose, the top bent into a kind of beak, and an oblique incision beneath the apex. This species is found in vegetable infusions, and in fetid hay, and usually moves with great velocity. It is pellucid, and appears as if filled with little bright vesicles, which differ in size. Some have supposed them to be lesser animalcules which the Kolpoda has swallowed; but as it has no mouth wherewith to swallow, Müller is more probably right in regarding them in the light of germs. When about to die in consequence of evaporation, it protrudes its contents, whether food or offspring, with great violence. Plate XLIII. fig. 25, 26, 27, 28.

Genus Bursaria.—Body simple, membranaceous, concave.

This genus occurs in fresh, saline, and stagnant waters. It appears to vary its form beneath the eye of the observer, and, from a rounded flattened shape, assumes a concave or somewhat purse-shaped aspect.

Sp. 1. *Bursaria truncatella.*—Follicular, with a truncated apex. This species is visible to the naked eye. It moves from left to right, and from right to left; ascends to the surface in a straight line, and sometimes rolls about as it descends.

Sp. 2. *Bursaria bulina.*—Boat-shaped, labiated anteriorly. This species is pellucid and crystalline, with brilliant globules within it. It is concave on the upper side, and convex below.

Sp. 3. *Bursaria hirundella.*—With two small wing-like projections, which give it somewhat of the appearance of a bird. It is invisible to the naked eye, but appears under the microscope like a pellucid hollow membrane. Recent micrographical observers doubt if this species really pertains to the present genus. Plate XLIII. fig. 29.

Order II.—Appendiculated Infusoria.

Furnished exteriorly with projecting parts.

The animalcules of this second principal order or division, though still infinitely small, gelatinous, and transparent, are so far less simply organized than their predecessors, inasmuch as they are furnished with salient parts, such as hairs, horns, or tail-like appendages, or at least with such projecting organs as, for want of more appropriate terms, we are obliged to designate by those names. They multiply both by division and by the bursting forth of internal germs. Though their essential fluids, and the living tissue which contains them, are probably of a more compound nature than those of the naked Infusoria, they have not yet reached that point of organization in which special organs are developed for the performance of particular functions; and it is not till we reach the higher class of Polypi that these are distinctly perceptible.

"Il paraît," observes Lamarck, "par les nombreuses espèces déjà connues et publiées, que les Infusoires de cet ordre sont bien plus nombreux dans la nature que les Infusoires nus. Cela doit être ainsi d'après les principes que je me suis cru fondé à établir.

"En effet, dans les Infusoires nus, l'origine encore trop récente des races qui proviennent de celles, en petit nombre, qui furent générées spontanément, n'a permis à la durée de la vie et aux circonstances qui ont influé sur ces races, qu'une diversité peu considérable. Mais à mesure que la durée de la vie, que sa transmission dans les individus qui se sont succédés en se multipliant, et que les circonstances ont eu plus de temps pour exercer leurs influences, les races se sont diversifiées de plus en plus, et sont devenues plus nombreuses.

"Cet ordre des choses, qu'il est facile de reconnoître pour celui même de la nature, nous fait sentir pourquoi les *Infusoires* sont bien moins diversifiés et moins nombreux que les *Polypes.* Effectivement, quoique nous ne connaissions pas probablement tous les Infusoires, et que nous connaissions bien moins encore tous les Polypes, ce qui est déjà connu de part et d'autre indique que la diversité des Polypes est considérablement plus grande que des Infusoires. Aussi les Polypes sont plus éloignés de leur origine que les Infusoires." (*Animaux sans Vertèbres,* tome i. p. 433.)

The first genus of this order (*Trichoda*), as constituted by Müller, contains several species which manifest the rudiments of a mouth and the commencement of an alimentary canal: these, according to the negative characters of the class, do not belong to the Infusoria.

Genus Trichoda.—Body very small, transparent, diversiform, without caudal appendage, but garnished with soft hairs either on the whole or on part of its surface.

According to the views of Lamarck, this genus contains not only a great proportion of the genus *Trichoda* of Müller, but also the whole of the genus *Leucophra* of the Danish author. It is distinguished from *Kerona* by the want of the long, stiff, distant, corniform hairs which characterize the latter.

A. *Body ciliated over its entire surface.*

(Leucophra of Müller.)

Sp. 1. *Trichoda viridiscens.*—Greenish, cylindrical, opaque, thicker posteriorly. Found in sea-water.

Sp. 2. *Trichoda dilata.*—Body flattened, variable, with sinuated margins. Inhabits sea-water, and swims like a *Planaria.* It scarcely differs from the genus *Kolpoda,* except in being ciliated.

Sp. 3. *Trichoda scintillans.*—Of a green colour, oval, slender, and opaque. Occurs in stagnant water. A doubtful species, closely allied to *Volvox.*

Sp. 4. *Trichoda acuta.*—Ovate, with a sharpened point. Colour yellowish. Of this species the form is very variable. It occurs in sea-water among ulvæ. Plate XLIII. fig. 30, 31, 32.

Sp. 5. *Trichoda signata.*—Oblong, sub-depressed, with a blackish margin. Common in sea-water. This species is distinguished by a curved line in its centre, shaped like the letter *S,* one end of which sometimes assumes a spiral form.

Sp. 6. *Trichoda mammilla.*—Spherical, opaque, with an exsertile papilla. Occurs in the waters of marshes. It is of a dark colour, its short hairs are curved inwards, and it occasionally appears to project and draw in a little white protuberance.

B. *Body ciliated, or covered with short hair only over a part of its surface.*

(The greater proportion of the genus Trichoda of Müller.)

Sp. 7. *Trichoda grandinella.*—Spherical, pellucid, haired above. The minute ciliary appendages of this species are not easily discovered, as it seems to possess the power of withdrawing them at pleasure and instantaneously. It occurs both in pure water and that of infusions.

Sp. 8. *Trichoda cometa.*—Spherical, ciliated anteriorly, with one or more globular appendages behind. Found in pure water in the autumnal season. Plate XLIII. fig. 33, 34.

Sp. 9. *Trichoda solaris.*—Spherical and crystalline, its edges beset with diverging rays, which exceed in length the diameter of the body. This animalcule contracts and dilates, but is stationary in the same spot. In marine infusions. Plate XLIII. fig. 35.

Sp. 10. *Trichoda pubes.*—Oval oblong, gibbous, depressed anteriorly. The apex of this species is furnished with hairs, which are seldom visible till it is about to expire, when it protrudes and extends them vehemently, as if in a vain attempt to secure and detain a remaining particle of water.

Sp. 11. *Trichoda proteus.*—Oval, obtuse behind, with an elongated retractile neck. Apex haired. This species, according to Müller and Lamarck, is found in river water. It appears, however, to agree in general character and appearance with the *Proteus* described by Mr Baker, which usually occurs in the slimy matter adhering to the sides of vessels in which either animal or vegetable substances have been some time kept. That of which an account is given by Mr Adams was found in the slime produced by water containing small fishes, snails, &c. The body was something similar to that of a snail, but pointed at one end, while from the other proceeded a long, slender, "and finely proportioned neck, of a size suitable to the rest of the animal." If we credit Mr Baker, this animalcule, though its eyes are not discernible, plainly demonstrates by its actions that it can see; for though multitudes swim about in the same water, and its own progressive motion is

very swift, it never strikes against its neighbours, but directs its course with a dexterity "wholly unaccountable should we suppose it destitute of sight." Its entire shape bears a resemblance to that of a swan. See Plate XLIII. fig. 36 and 37. When alarmed, it draws in its supposed neck, becomes more opaque, and moves about slowly with the large end foremost. See fig. 38. After continuing for some time under this form, it will put forth a kind of wheel machinery, the motions of which are alleged to draw a current of water towards it from a considerable distance. After frequently pushing out and pulling in this shorter head, sometimes with and sometimes without the wheel-work, it will remain motionless, as if wearied or worn out; and then its long head and neck or apex will be again slowly protruded, after which it generally resumes its accustomed agility.

Genus Kerona.—Body very small, diversiform, without tail-like prolongation, and furnished with scattered, stiff, corniform hairs on some parts of its body.

To this genus Lamarck has united the Himantopus of Müller. The species are rare. They seldom occur in infusions, and are most frequent in the purer kinds of fresh and salt waters.

Sp. 1. *Kerona rostellum.*—Orbicular and membranaceous; one side angulated, the other furnished with a series of triple horns. Inhabits sea and river water. This species is alleged by Bory de St Vincent to be entirely destitute of hairs and cirri, and he therefore proposes to remove it to the order *Gymnodes*, which corresponds with our first order, the naked Infusoria. It is sometimes difficult to identify species in this department, or to ascertain, in a doubtful or contested case, that the same animalcule has been the subject of observation by two or more disputants. Plate XLIII. fig. 39.

Sp. 2. *Kerona cypris.*—Somewhat pear-shaped, compressed, the front furnished with hairs or vibrating points, inserted beneath the edge, shorter behind, and partly extended straight forward, partly bent downwards. Motion retrograde. Inhabits fresh water.

Sp. 3. *Kerona ludia.*—Smooth, pellucid, full of small points, the fore part clubbed and a little bent, the hinder part narrow; the base obliquely truncated, and terminating in a tail stretched out transversely. The top of that part which may be called the head, and the centre of the back, are furnished with long hairs. When this animalcule is at rest, its tail is curled; when in motion it is drawn tight and extended upwards. The movements of this species are lively and diverting.

Genus Cercaria.—Body very small, transparent, diversiform, furnished with a distinct but very simple tail.

This genus, as constituted by Müller, contains many species which bear no natural relation to each other; but his characters are precise and definite, and strictly applicable to those species which now form the genus as limited by modern observers. They occur more rarely among animal and vegetable infusions than in running streams and the waters of marshes. Their movements are for the most part circular and very rapid. With the exception of a well-marked tail, their organization is in every other respect extremely simple. If a mouth and the rudiment of a stomach or alimentary canal exist in any of these animals, such characters would remove them not only from the genus Cercaria, but from the class Infusoria, as defined at the commencement of this treatise. *A fortiori*, the existence of eyes (a fact assumed by some inaccurate observers) in any of the animalcular species, would entirely alter their position and arrangement in the animal kingdom. We cannot do better than report the observations of the venerable Lamarck (himself unfortunately now deprived of sight) on this obscure subject:—"Ici, comme dans le genre suivant, l'on est exposé, d'après la petitesse extrême des individus, à rapporter à la classe des Infusoires des animaux qui, par leur organisation, appartiennent à d'autres points de l'échelle animale."

"Une bouche, quoique d'abord inaperçue, et conséquemment l'ébauche d'un sac alimentaire, peuvent exister dans certains de ces animaux, et dès-lors ils appartiennent au premier ordre des Polypes; mais des yeux, comme on en a supposé dans certains Cercaires, cela est impossible.

"Avant de dire que le fait lui-même vaut mieux que la raisonnement, il faut, 1*mo*, constater que les points que l'on a pris pour des yeux, en sont réellement, et qu'ils ont chacun un nerf optique qui se rend à une masse médullaire, centre de rapports pour des sensations; 2*do*, il faut ensuite établir positivement que des animalcules réellement pourvus d'yeux, sont néanmoins, par leur organisation, de la même classe que les Infusoires." (*Animaux sans Vertèbres*, tome i. p. 444.)

This genus forms the nucleus of the new family of Infusoria proposed by M. Bory de St Vincent under the name of *Cercariées*, and which contains in all seven genera, the names and nature of which will be seen by referring to the tabular view. Müller, who was not practically acquainted with the spermatic animalcules, was attracted by the resemblance which some of the Cercariæ bore to the figures of those organic molecules in the works of his predecessors. He did not, however, assert their identity; and probably perceived that, although in their general aspect and mode of movement they resembled each other, their peculiar and very different localities, and even the details of their structure, rendered it advisable that they should be assigned to separate genera.[1]

Sp. 1. *Cercaria inquieta.*—Changeable, convex, with a slender tail. This species occurs in salt water, and is remarkable for assuming a variety of different forms. It is sometimes oval, sometimes cylindrical, sometimes shaped like a sphere. Plate XLIII. fig. 40.

Sp. 2. *Cercaria gyrinus.*—Body of a rounded form, with an acuminated tail. In swimming, this animalcule moves its tail like a tadpole.

Sp. 3. *Cercaria lemna.*—Changeable, sub-depressed, with an annulated tail. The C. lemna varies the form of its body in a manner almost as singular as that exhibited by the *Proteus*, already described. The body is triangular, or oblong, or kidney-shaped. Its tail is at times thick, short, annulated; at others it is long, cylindrical, and without rings; and when stretched out it sometimes vibrates with such velocity as to appear double. A small pellucid globule, which Müller regarded as the mouth, is perceptible near the apex; and there are also two excessively minute black points, which, whatever they may really be, are by some called eyes. It advances slowly by a few steps or movements at a time, and frequently shakes and bends its tail, in which position it bears a great resemblance to a

[1] The following are the characters of the genus *Zoosperma*, as recently established: "Corps non contractile, ovoïde, très-comprimé, avec une queue setiforme, aussi longue ou beaucoup plus longue, implantée à la partie postérieure, qui est peu ou point amincie. Ce genre, dont nous possédons un très-grand nombre d'espèces, se compose d'animaux spermatiques." (*Dict. Class. d'Hist. Nat.* tome iii. p. 356.) The production and existence of these animals, their nature and uses, are still among the many inscrutable mysteries of nature.

lemna leaf in miniature. This animalcule exhibits an advanced organization. Plate XLIII. fig. 41, 42, 43.

GENUS FURCOCERCA.—Body very small, transparent, rarely ciliated, furnished with a bipartite tail.

This terminal genus, according to the views of Lamarck, conducts us to the limits of the infusorial class, and we become thus more liable to deception in regard to the non-existence of a mouth than in the preceding genera. It is a dismemberment of the *Cercaria* of Müller, and probably contains many species which will be placed elsewhere when future and more continuous observation shall have thrown additional light upon their nature and attributes.

Sp. 1. *Furcocerca podura.*—Cylindrical, acuminated posteriorly. This species is pellucid, and seems to consist of a head, trunk, and tail, the first of which, in the view of some observers, "resembles that of a herring." It turns round as if upon an axis when it moves, and is usually found in the months of November and December, in places where the lemna abounds. The tail frequently, but not always, appears to be divided into two. One of Müller's figures of this species is probably erroneous. He represents it as covered with short hairs; whereas, to more recent observers, it appears perfectly smooth. Plate XLIII. fig. 44, 45.

Sp. 2. *Furcocerca viridis.*—Cylindrical, variable, divided and acuminated behind. Occurs in spring in ditches and standing pools. It frequently contracts its anterior and posterior portions, so as to assume a spherical form. It is difficult to determine the genus to which this species belongs. Lamarck is supposed to have erred in placing it where it now stands. In truth, the genus appears to have been rather established provisionally, than upon an assured and natural foundation. The varying forms of the species which it contains render it extremely difficult either to discern or describe them with precision. Plate XLIII. fig. 46, 47, 48.

We have now endeavoured to present a general view, and a systematic exposition, of the principal features of the animalcular world; and if our statements have been less explicit, and our arrangement less complete and methodical, than accords with the reader's expectation, these defects must in part be attributed to the uncertainty which still prevails regarding a subject of which many of the essential characters scarcely lie within the limits of human intelligence. The observations and experiments of the English microscopical observers of last century, though they might amuse the general student, are too vague and fanciful to be now regarded as parts of the assured history of animalcules. The ultra-analogical reasoning on subjects of natural science with which we have been lately favoured by such men as Oken and Geoffroy St Hilaire, are tame in comparison with the inferences deduced by some of our older observers, who describe with minuteness the head, eyes, mouth, jaws, throat, stomach, intestines, and other parts of animalcules, which the improved glasses of modern times do not reveal to the vision of not less patient inquirers. The recent observations on the motions of the pollen of plants, which have puzzled the modern philosophers, would have opposed but feeble barriers in the way of our predecessors. "To discover," says Buffon, "whether all the parts of animals, and all the seeds of plants, contained moving organic particles, I made infusions of the flesh of different animals, and of the seeds of more than twenty different species of vegetables; and after remaining some days in close glasses, I had the pleasure of seeing organic moving particles in all of them. In some they appeared sooner, in others later; some preserved their motions for months, and others soon lost it. Some at first produced large moving globules resembling animals, which changed their figure, split, and became gradually smaller; others produced only small globules, whose motions were extremely rapid; and others produced filaments, which grew longer, seemed to vegetate, and then swelled and poured forth torrents of moving globules." It was from these and similar observations that the theory arose proposed by Baron Munchausen (an ominous name!). The Baron perceiving that these moving globules, after taking a little exercise, began again to vegetate, drew the conclusion that they were first animals and then plants; thus anticipating by more than half a century the supposed discoveries of some modern physiologists. Which of them was first in error it is perhaps of little consequence to inquire; and we allude to the subject here rather in connection with some singular observations by Mr Ellis, recorded in the 59th volume of the *Philosophical Transactions,* than from its own intrinsic importance. His object was to overturn Munchausen's hypothesis, by showing that the supposed Zoocarpes were nothing more than "the seeds of that genus of fungi called *mucor* or *mouldiness,*" and that their motions were caused by the attacks of myriads of animalcules! "Having at the request of Dr Linnæus made several experiments on the infusion of mushrooms in water, in order to prove the theory of Baron Munchausen, that these seeds are first animals and then plants, it appeared evidently that the seeds were put in motion by very minute animalcules, which proceeded from the putrefaction of the mushroom: for by pecking at these seeds, which are reddish, light, round bodies, they moved them about with great agility in a variety of directions; while the little animals themselves were scarcely visible till the food they had eaten had discovered them. The satisfaction I received from clearing up this point led me into many other curious and interesting experiments. The ingenious Mr Needham supposes these little transparent ramified filaments, and jointed or coralloid bodies, which the microscope discovers to us on the surface of most animal and vegetable infusions when they become putrid, to be zoophytes, or branched animals; but to me they appear, after a careful scrutiny with the best glasses, to be of that genus of fungi called *mucor* or *mouldiness,* many of which Michellius has figured, and Linnæus has accurately described. Their vegetation is so amazingly quick, that they may be perceived in the microscope even to grow and feed under the eye of the observer. Mr Needham has pointed out to us a species that is very remarkable for its parts of fructification (See *Phil. Trans.* vol. xlv. tab. 5, fig. 3, *a,* A). This, he says, proceeds from an infusion of bruised wheat. I have seen the same species proceed from the body of a dead fly, which was become putrid by lying floating for some time in a glass of water where some flowers had been, in the month of August 1768. This species of mucor sends forth a mass of transparent filamentous roots; from whence arise hollow stems, that support little oblong oval seed-vessels, with a hole on the top of each. From these I could plainly see minute globular seeds issue forth in great abundance, with an elastic force, and turn about in the water as if they were animated. Continuing to view them with some attention, I could just discover that the putrid water which surrounded them was full of the minutest animalcula; and that these little creatures began to attack the seeds of the mucor for food, as I have observed before in the experiment on the seeds of the larger kind of fungi or mushrooms. This new motion continued the appearance of their being alive for some time longer; but soon after many of them arose to the surface of the water, remaining there without

motion; and a succession of them afterwards coming up, they united together in little thin masses, and floated to the edge of the water, remaining there quite inactive during the time of observation." In like manner, the movements of the jointed coralloid bodies which Mr Needham has named *chaplets* and *pearl necklaces* are attributed to the attacks of their animalcular enemies. "When a small portion of these branches and seeds are put into a drop of the same putrid water upon which the scum floats, many of these millions of little animalcula with which it abounds immediately seize them as food, and turn them about with a variety of motions, as in the experiments on the seeds of the common mushrooms, either singly, or two or three seeds connected together; answering exactly to Mr Needham's description, but evidently without any motion of their own, and consequently not animated!"

We shall conclude this subject with a short notice of another view of the matter, which has resulted from some recent experiments and observations by our celebrated botanist Robert Brown. While engaged in some inquiries regarding the structure of the pollen of plants, and its mode of action on the pistillum of phænogamous tribes, that accurate observer had occasion to immerse in water some particles taken from the full-grown anthers (previous to bursting) of *Clarkia pulchella*. Of these, he perceived by the microscope that many were evidently in motion, and that their motion consisted not only of a change of place in the fluid, but of a change of form in themselves; that is to say, a contraction or curvature about the middle of one side, accompanied by a corresponding enlargement or convexity on the other, frequently occurred. The particles were seen, in a few instances, to turn on their longer axis; and their general motions were of such a nature as to produce the conviction in Mr Brown's mind that they did not arise either from currents or evaporation of the fluid, but were proper to the particles themselves. Having ascertained that motion existed in the pollen of all the living plants which he examined, he next inquired whether, and for what length of time, this singular property was retained after the death of the plant. Specimens were experimented on, which had been dried and preserved in an herbarium for 100 years, and the moving molecules or small spherical bodies were still perceived in considerable numbers. "The very unexpected fact," says Mr Brown, "of seeming vitality retained by those minute particles so long after the death of the plant, would not perhaps have materially lessened my confidence in the supposed peculiarity; but I at the same time observed, that on bruising the ovula or seeds of Equisetum, which at first happened accidentally, I so greatly increased the number of moving particles, that the source of the added quantity could not be doubted. I found also, on bruising first the floral leaves of mosses, and then all other parts of those plants, that I readily obtained similar particles, not in equal quantity indeed, but equally in motion. My supposed test of the male organ was therefore necessarily abandoned. Reflecting on all the facts with which I had now become acquainted, I was disposed to believe that the minute spherical particles or molecules of apparently uniform size, first seen in the advanced state of the pollen of Onagrariæ, and most other phænogamous plants,—then in the antheræ of mosses, and on the surfaces of the bodies regarded as the stamina of Equisetum,—and, lastly, in bruised portions of other parts of the same plants,—were in reality the supposed constituent or elementary molecules of organic bodies, first so considered by Buffon and Needham, then by Wrisberg with greater precision, soon after and still more particularly by Müller, and very recently by Dr Milne Edwards, who has revived the doctrine, and supported it with much interesting detail. I now, therefore, expected to find these molecules in all organic bodies; and accordingly, on examining the various animal and vegetable tissues, whether living or dead, they were always found to exist; and merely by bruising these substances in water, I never failed to disengage the molecules in sufficient numbers to ascertain their apparent identity in size, form, and motion, with the smaller particles of the grains of the pollen. I examined also various products of organic bodies, particularly the gum raisins, and substances of vegetable origin, extending my inquiry even to pit-coal; and in all these bodies molecules were found in abundance. I remark here also, partly as a caution to those who may hereafter engage in the same inquiry, that the dust or soot deposited on all bodies in such quantity, especially in London, is entirely composed of these molecules. One of the substances examined was a specimen of fossil wood, found in Wiltshire oolite, in a state to burn with flame; and as I found these molecules abundantly and in motion in this specimen, I supposed that their existence, though in smaller quantity, might be ascertained in mineralized vegetable remains. With this view, a minute portion of silicified wood, which exhibited the structure of coniferæ, was bruised, and spherical particles, or molecules in all respects like those so frequently mentioned, were readily obtained from it; in such quantity, however, that the whole substance of the petrifaction seemed to be formed of them. But hence I inferred that these molecules were not limited to organic bodies, nor even to their products. To establish the correctness of the inference, and to ascertain to what extent the molecules existed in mineral bodies, became the next object of inquiry. The first substance examined was a minute fragment of window-glass, from which, when merely bruised on the stage of the microscope, I readily and copiously obtained molecules, agreeing in size, form, and motion, with those which I had already seen. I then proceeded to examine, and with similar results, such minerals as I either had at hand or could readily obtain, including several of the simple earths and metals, with many of their combinations. Rocks of all ages, including those in which organic remains have never been found, yielded the molecules in abundance. Their existence was ascertained in each of the constituent minerals of granite, a fragment of the sphinx being one of the specimens examined. To mention all the mineral substances in which I have found these molecules would be tedious; and I shall confine myself, in this summary, to an enumeration of a few of the most remarkable. These were both of aqueous and igneous origin, as travertine, stalactites, lava, obsidian, pumice, volcanic ashes, and meteorites from various localities. Of metals I may mention manganese, nickel, plumbago, bismuth, antimony, and arsenic. In a word, in every mineral which I could reduce to powder sufficiently fine to be temporarily suspended in water, I found these molecules more or less copiously; and in some cases, more particularly in siliceous crystals, the whole body submitted to examination appeared to be composed of them."

There were three points of importance which Mr Brown was anxious to ascertain regarding these molecules, viz. their form, whether they were of uniform size, and their absolute magnitude. He seems, however, not to have been entirely satisfied with his determination on any of these points. As to form, he states the molecules to be spherical. His manner of estimating the absolute magnitude and uniformity of size of the molecules found in the various bodies submitted to examination, was by placing them on a micrometer divided to five thousandths of an inch, the lines of which were very distinct; or, more rare-

Animalcule.

ly, on one divided to ten-thousandths, with fainter lines, not readily visible without the application of plumbago, as employed by Dr Wollaston, but which in this case was inadmissible. The results can only be regarded as approximate, but Mr Brown is disposed to believe that the molecule is of uniform size, though, as existing in various substances, and examined in circumstances more or less favourable, he regards it necessary to state that its diameter appeared to vary from $\frac{1}{15000}$th to $\frac{1}{20000}$th of an inch.[1]

Supplementary Observations.—1853.

Since the preceding exposition of animalcules was written, great and important additions have been made to our knowledge of the subject. Both the organic structure and the physiological functions of these creatures have been described at great length, and amply illustrated, by Ehrenberg of Berlin. We are deeply indebted to that author for much that he has achieved in an obscure and difficult department,—for his general views, not less than his detailed descriptions,—and especially for the influence which he has shown many animalcular beings to have exercised, by means of their siliceous remains, in the building up, as it were, of various geological formations. At the same time it must be borne in mind, that many of Ehrenberg's discoveries have been much contested, and that Dujardin and other recent writers do not accept his classification, in consequence of what they deem its hypothetical basis. In presenting the views of the first-named observer, we therefore do so under a sense of the critical correction which others have sought to bestow upon them, and of which we shall also in our present supplement endeavour to give a brief account.

The following is a summary of Ehrenberg's views of the general character and attributes of infusorial beings.

They are all organized,—the greater portion (probably all of them) highly organized bodies.

They constitute two very natural classes (Polygastrica and Rotatoria), according to their structure, and are further subdivisible upon the same principle.

Their existence in all quarters of the earth and sea, is proved; as is also that of individuals of the same species in the most opposite ends of the world.

Their geographical distribution upon the earth follows the laws observed as regulating that of other natural bodies.

Most of the Infusoria are invisible to the naked eye; many are just visible as moving points; the size of the body does not in any case exceed $\frac{1}{12}$th of an inch.

Invisible Infusoria, in consequence of their vastly aggregated numbers, colour large tracts of water with remarkable hues.

Though themselves invisible, they also give rise, in consequence of this aggregation, to a certain kind of marine phosphorescence.

They sometimes compose, though singly invisible, a kind of mould, very obvious in consequence of the multitudinous mass. In a single cubic inch of this mould, there may be above 41,000 millions of animalcules; and they probably constitute the chief proportion of living bodies on the face of the earth.

They are the most reproductive of all organized beings; and from one of their known modes of propagation, that of self-division, ensues a continual destruction of the individual, and yet a similar interminable preservation and extension of it, in air and water, bordering, it may be almost said, upon eternal life and growth.

The copulation of gemmæ, which perhaps includes the hitherto unsolved poly-embryonate riddle of the seeds of all plants and vegetable formations, is solved in the animalcular family of Closterina.[2]

They form in the course of time, in consequence of the enduring nature of their siliceous shells, indestructible earths, stones, and rocky masses.

With lime and soda we can prepare glass and swimming bricks out of invisible animalcules; we can use them as flints, and probably prepare iron from them; we use *mountain meal*, which is composed of them, as food in hunger.

They are sometimes injurious, by causing the death of fish in ponds, deteriorating clear water, and causing boggy smells; but they do not, as some have supposed, give rise to malaria, plague, and other maladies.

They appear to be, as far as yet known, sleepless.

They partially break up in reproduction (egg-laying), and thereby passively undergo great alterations of form.

They form invisible intestinal beings in man and other animals, even if the Spermatozoa are excluded from among them. They are themselves infected by both external and internal parasites.

[1] The following summary from the pen of Mr Brown contains the renewed expression of that gentleman's opinion, matured by some recent experiments on the subject of active molecules. "That extremely minute particles of solid matter, whether obtained from organic or inorganic substances, when suspended in pure water or in some other aqueous fluids, exhibit motions for which I am unable to account, and which, from their irregularity and seeming independence, resemble in a remarkable degree the less rapid motions of some of the simplest animalcules of infusions. That the smallest moving particles observed, and which I have termed Active Molecules, appear to be spherical, or nearly so, and to be between $\frac{1}{20000}$th and $\frac{1}{30000}$th of an inch in diameter; and that other particles of considerably greater and various size, and either of similar or of very different figure, also present analogous motions in like circumstances. I have formerly stated my belief that these motions of the particles neither arose from currents in the fluid containing them, nor depended on that intestine motion which may be supposed to accompany its evaporation. These causes of motion, however, either singly or combined with others,—as the attractions and repulsions among the particles themselves, their unstable equilibrium in the fluid in which they are suspended, their hygrometrical or capillary action, and in some cases the disengagement of volatile matter, or of minute air-bubbles,—have been considered by several writers as sufficiently accounting for the appearances. Some of the alleged causes here stated, with others which I have considered it unnecessary to mention, are not likely to be overlooked, or to deceive observers of any experience in microscopical researches; and the insufficiency of those enumerated may, I think, be satisfactorily shown by means of a very simple experiment. This experiment consists in reducing the drop of water containing the particles to microscopic minuteness, and prolonging its existence by immersing it in a transparent fluid of inferior specific gravity, with which it is not miscible, and in which evaporation is extremely slow. If to almond oil, which is a fluid having these properties, a considerably smaller proportion of water, duly impregnated with particles, be added, and the two fluids shaken or triturated together, drops of water of various sizes, from $\frac{1}{50}$th to $\frac{1}{2000}$th of an inch in diameter, will be immediately produced. Of these, the most minute necessarily contain but few particles, and some may be occasionally observed with one particle only. In this manner minute drops, which, if exposed to the air, would be dissipated in less than a minute, may be retained for more than an hour. But in all the drops thus formed and protected, the motion of the particles takes place with undiminished activity, while the principal causes assigned for that motion, namely, evaporation and their mutual attraction and repulsion, are either materially reduced or absolutely null."

[2] Among other difficulties with which the student of this department will have to contend is the following,—that many species classed by Ehrenberg and others as animalcules, are considered by botanists as pertaining to their particular kingdom. Thus the Desmidiaceæ, a great component group of Ehrenberg's family Basillaria, are viewed by Professor Bailey of New York as belonging to the vegetable kingdom. Among ourselves, Dr Harvey, so noted for his knowledge of marine plants, classes both these and the Diatomaceæ, as suborders of the *Chlorospermeæ*, or green *Algæ*. Mr Ralfs, who has written so excellent a monograph on the "British Desmidieæ," likewise regards these as Algæ. It is indeed a vexed question as to the animal nature even of the Diatomaceæ, which, by means of genera such as *Melosira*, and others, seem closely connected with the confervoid Algæ.

Animalcule.

They possess comparatively a lengthened life.

As the pollen of pine trees falls yearly in the form of sulphur-rain, so do the much more minute animalcules appear (being elevated by means of watery vapour) floating alive in the atmosphere, and sometimes even mixed with dust.

They generally, like the more highly-organized bodies, maintain themselves pretty uniformly against all external influences. Although they sometimes consume strong poisons without immediate injury, they do not do so without an after effect.

The weight of invisible Infusoria, although light, is calculable, and the most gentle current of air or draught can play with their bodies as with the vapour of water.

The obvious and very rapid motion of Infusoria, is reducible as follows:—*Hydatina senta* moves 1-12th of an inch in 4 seconds; *Monas punctum*, the same in 48 seconds; while *Navicula gracilis* takes 6 minutes 24 seconds to go the same distance.

Linnæus said, *omnis calx e vermibus:* either to maintain or deny *omnis silex omne ferrumve vermibus* would now be unjust.

Direct observations on the theory of *generatio primativa* are wanting in necessary strictness. Those who profess to have seen the sudden origin of the minutest Infusoria from elementary substances, have quite overlooked the compound structure of these organic bodies.

The frequent and wonderful changes of form of many Infusoria no doubt have their limits, although the laws which govern them are still to be defined.

The power of infusorial organization is exhibited by the strong chewing apparatus, with teeth, which they possess, and their exhibition, also, of a complete mental activity.

The study of the Infusoria has led to a more distinct and conclusive notion of animal organization in general, and of the limits which circumscribe the animal form; from which all plants and minerals, which want the animal organic system, are strongly and distinctly separated.

It finally results from these inquiries, that experience shows an unfathomableness of organic creations, when attention is devoted to the smallest space, as it does of stars when directed to distances the most immense.

It was the prevailing opinion, till of later years, that the generality of animalcules were devoid of external organs; but the use of coloured substances, and the introduction of achromatic glasses have certainly shown a much more composite structure than was formerly known to exist. The simplest member is a delicate filament, placed near the oral orifice, and therefore called the *proboscis*. When the animalcule is in motion, this proboscis seems to act as a sort of oar or paddle, while, at the same time, by creating a current in the direction of the mouth, it aids in the prehension of food. *Cilia* are shortish hairs, placed apparently upon a bulb. They vibrate rapidly, the hair turning round upon something like an articulated surface, while the points describe a comparatively large circle. These cilia show themselves remarkably among the Rotatoria, in the shape of wheels, and both in form and action may be regarded as among the most interesting spectacles presented by the animalcular world. Naturalists are somewhat divided regarding their functions. Many look upon them as organs of respiration, and there is no doubt that corresponding parts are placed around the gills of many mollusca, and bring to them currents of fresh water for the purposes of breathing. Of the existence of *eyes* in the animalcular world we are still extremely doubtful, when we consider the fact of their non-existence in great groups distinguished in all other respects by a more complex and complicated organization. In Müller's great work no eyes are represented in any of the Polygastric species, but certain specks containing a red pigment have been assumed as eyes by Ehrenberg; and he argues that even if no other proof of the existence of a nervous system in these animated atoms could be adduced, the visual spots referred to would be sufficient to prove it. Having, as he supposes, discovered visual organs in these red specks of the Rotatorial families, he argues from analogy that the same parts perform similar functions in the Polygastric groups. M. Valenciennes maintains that in the Rotatoria these eye-specks are distinctly defined, have an investing capsule, and a crystalline lens, and consequently possess the essential attributes of organs of sight. On the other hand, owing to the extreme minuteness of the Polygastric species, all appearance of definite outline is wanting in their red specks, and as similar characters occur upon the reproductive germs of *Algæ* (which belong to the vegetable kingdom), their necessarily visual character is denied by many considerate observers.

"The sense of sight," says M. Dujardin, "would partake more of the character of a reality if the colour of a speck without appreciable organization, without a constant form, or a precise contour, sufficed to prove the existence of an eye. But in the genus *Euglena*, which is particularly cited as characterized by such an organ, the red spot so regarded is excessively variable, sometimes multiple, at other times made up of irregularly aggregated granules. Analogy, too, is inadequate to the solution of the question; for, on descending the animal series, to determine the nature of this coloured speck, we have to leap from the Daphniæ (an *Entomostracal* tribe) with a moveable eye, repeating in its composition that of Insects and Crustacea, to animals presenting nothing but diffused coloured specks.

"Such spots, whether in number or position, have so little physiological importance in the Planariæ, and in certain Annelides, that they are often not even to be employed as an absolute specific character. In the Rotatoria, the analogy with which is more especially insisted on, these pigment spots are, in some species, known to disappear from age, and in others to become more evident in proportion to size or development of individuals: so that the learned micrographer of Berlin, in his attempt to base the generic characters of these animals on the presence and number of eyes, has been led to place in different genera, species very closely allied, if not identical. Indeed, that a black or a red colour is in general an attribute of the pigment of eyes, cannot be a reason for concluding an eye to exist wherever we find such colours; if so, we must accord it to some intestinal worms, such as the *Scolex polymorphus*, which has two red spots on the neck, to the *Actiniæ*, which are often strewed with such specks, and also to some bivalved mollusks.

"If the ability of the Infusoria to direct their course through the liquid, and to pursue their prey, be appealed to in evidence, it is certainly, in the first place, necessary to verify the reality of this faculty, which I think equally fabulous with all related concerning the instincts of these animals. Indeed it would not even prove the red specks to be eyes, since the greatest number of Infusoria supposed to be endowed with such a faculty are in want of them; and those which do possess them do not exhibit that power in any higher degree of development."[1]

In the opinion of M. Morren, the red pigment specks of *Lagenella*, *Cryptoglena*, and *Trachelomonas*, cannot be eyes, because in the last-named genus the coloured pigment is capable of being distributed over the whole body, in which case, according to Ehrenberg's supposition, the creature itself would be converted into nothing but an eye.[2]

Professor Owen observes, in relation to the movements of Polygastric animalcules, that although they may be per-

[1] *Histoire des Infusoires.*

[2] *Mem. de l'Acad. de Bruxelles*, 1841, taf. 14.

Animalcule.

ceived to avoid obstacles in their way, and rarely jostle one another, it is yet difficult to detect any definite cause or object of their movements.[1] After carefully watching for signs of volition, that great observer came to the conclusion that those movements partook in general of the nature of respiratory acts, rather than of attempts to obtain food or avoid danger. They seemed automatic rather than voluntary, as if governed by stimuli within or without the body, not felt, but reflected upon contractile fibre, and are therefore motions which never tire. He thus explains the fact already indicated in our abstract of Ehrenberg's general views, namely, that at whatever period of the night we examine living Infusoria, we shall invariably find them as ceaselessly active as during the meridian splendour, and thus that animalcules never sleep.

The same unsettled state of opinion as regards the eyes, pervades our knowledge of other important parts of animalcular economy, and even the great basis (the assumed peculiarities of the digestive system) of Ehrenberg's classification being regarded as hypothetical, the classification itself has been by many rejected on that ground. According to the Berlin naturalist, the functions of digestion among the Polygastrica are effected by means of numerous internal vesicles or stomachs; while in the Rotatoria, as in the generality of higher animals, there is only one. While studying species of the former class, Ehrenberg observed a vesicle to fill with food, and then saw the particles pass into another cell, and so on until, the nutritive portions having been imbibed by each stomach in succession, the refuse was discharged by the animalcule. That many other naturalists have been unable to detect this process is perhaps no conclusive argument against it, as great experience, and the most steadfast and accurate observation, are necessary in microscopical pursuits. Few have been able to detect the tubular connection between these stomachic cells, which, however, must exist if Ehrenberg's views are well founded. He affirms that he has often seen it, and the passage is very distinctly shown upon his plates. Baron Gleichen regarded these vesicles as eggs, although he failed to witness their discharge; and the existence of eggs among the Polygastric tribes, is perhaps as much of an assumption as any other. So far back as 1781, he tried to make certain Infusoria eat carmine, and found on the ensuing day that several of them had red granules in their interior.[2] He concluded that they had swallowed the colouring matter, and more recent repetitions of similar experiments led to the formation of Ehrenberg's system. Professor F. T. Meyen refuses to admit the facts on which it is founded, not only because he has failed to see the intestinal communication between the stomachs, but has observed these supposed stomachs moving rapidly in the interior of the body of many species, after the manner of those granules which circulate in the joints of *Chara*. He has often seen *Vorticellæ* with many globules of indigo in their interior, always moving round a centre; from which he infers there could not be a communicating canal between the so-called stomachs with an oral orifice, and an extremity directed towards the mouth. In regard to the true nature of these vesicles, and balls of similar diameter, found in the bodies of Infusoria, Meyen is of opinion that the true Infusoria are themselves vesicular beings, the interior of which is filled with a mucous substance: the thickness of the membrane forming the vesicle is easily ascertainable in several species, and in many he has noticed in this membrane an obvious spiral structure, resembling that which exists among cellular vegetables. In the larger Infusoria, a cylindrical canal (the œsophagus) traverses obliquely the membrane which forms the animal. The lower extremity of this canal dilates, more or less, when the creature has taken food, until it attains the dimensions of the balls, which are so obvious in the interior of these Infusoria. The inner surface of this upper portion of the intestinal canal is provided with cilia, which turn round not only alimentary substances but foreign bodies, till they have assumed a spherical form. During the formation of this ball, the stomach, according to Meyen (who admits that the part in question must be distinguished by that name), has a free communication with the œsophagus; and by means of the ciliary apparatus found at its exterior, new alimentary substances are introduced into this canal, and pushed as far as the stomach. When the ball has acquired the dimensions of the stomach, it is expelled by its inner extremity, and pushed into the cavity of the body. It there forms an additional ball, if any solid substances had previously existed in the surrounding liquid. This second ball is itself pushed into the interior of the cavity of the animal, and drives before it the first ball along with the mucosities between the two—a successive formation of similar balls, by the food or other matter received into the animal, going on without interruption. Now, Meyen maintains that it is the simultaneous existence of many of these balls which has caused Ehrenberg to believe that these animalcules were *Polygastric*. To follow their formation, our observations must commence at the moment the animalcules are plunged into coloured liquid. The swallowing of the coloured particles takes place with great rapidity, frequently in half a minute, and the coloured balls may be seen one after another issuing from the stomach, and proceeding downwards along the internal wall of the cavity of the body. Their number is often so considerable as to fill the entire cavity, and they lie so close together as to form a large mass, which, as in the genus *Vorticella*, slowly turns upon itself. The vesicular cavities, according to Meyen, are not stomachs, and possess nothing in common with the balls, although the latter may get into them singly, but at the same time accidentally. The formation of these cavities, as well as their sudden and entire disappearance, may be traced as easily as the origin of the balls. It is even possible sometimes to see how one of these cavities moulds itself over a ball, and then disappears. The microscope reveals to us that they are not lined with a particular membrane, but are simply excavations of the pulpy substance. They often show themselves close to the inner surface of what forms the skin of the creature, and sometimes increase so greatly, that the diameter of even one is equal to the third or one-half of the entire cavity of the body.[3]

[1] *Comparative Anatomy and Physiology of the Invertebrated Animals*, p. 19.

[2] As the use of infusions is indispensable in the study of living microscopic objects, we extract the following notice of the method of feeding infusoria with coloured substances, from Mr Pritchard's work. Select for the purpose such coloured substances as are entirely free from metallic oxides, and not chemically soluble in water. They must, however, be capable of a very minute mechanical division. The substances generally used are carmine, indigo, and sap-green, the first being preferable. The material should be as pure as possible. Rub a piece of it once or twice on the stage glass, or what is better, the lower plate of an aquatic air-box, having first moistened it with a drop of water. The quantity of colour requisite is very small, no more than sufficient to render it appreciable by the naked eye; for if there be too much, the chances are that the particles will be too large for the creatures to imbibe. Having thus prepared the coloured food, place a drop of it beside a drop of water containing the animalcules, but not so near as that they may come in contact; then put gently on the cover of the air-box, and lower it sufficiently to flatten the two drops of fluid, but not to force them to unite. Now place the air-box under the microscope, and examine the animalcules closely, so as to ascertain that their stomachs are colourless; then press down the cover until the drops of fluid intermingle, which may be done under the microscope, and you will immediately perceive the creatures in great activity, and readily distinguish the cilia and proboscis of such as possess those parts, while in a few seconds their stomachs will be filled by the coloured substance.—See *Infusorial Animalcules*, p. 103. 2d Ed. 1852.

[3] *Edin. Phil. Jour.*, vol. xxviii.

According to Dujardin, the Infusoria (setting aside the *Systolides* or *Rotatoria*, as much higher in the animal scale, and also the *Bacillaria*, which, with *Closteria*, are more nearly related to the vegetable kingdom) derive their origin for the most part from obscure or unknown germs, in artificial and natural infusions, stagnant water, and rivers, or such portions of them as rest over vegetable remains; no other mode of propagation, except self-division, being well ascertained. Their fleshy substance is dilatable and contractile, like the muscular flesh of the higher animals, but it exhibits no absolute trace of fibres or membrane, seeming, on the contrary, to be homogeneous and diaphanous, except in cases where the surface appears articulated from contraction. This fleshy matter when isolated by tearing, or the death of the animalcule, shows itself in the liquid in the form of lenticular discs or globules, which refract light but slightly, and are capable of producing spontaneously in their substance spherical cavities analogous in appearance to the vesicles of the interior. In the living creature some of these vesicles are produced at the base of a sort of mouth, and are destined to contain the water swallowed with the aliments. They then pursue a certain course in the interior, and contract, and leave nothing in the centre of the fleshy substance, except the undigested particles. They can even discharge their contents externally by a fortuitous opening, which may be reproduced several times towards the same, though not the identical, point. The vesicles containing the aliment are independent, and neither communicate with an intestine, nor with each other, except in those cases where two vesicles incorporate. The other vesicles, which contain nothing but water, are formed much nearer the surface, and seem capable both to receive and expel their contents through the meshes of the integument. Spallanzani considered them as respiratory organs, and they may be so regarded, at least in so far as they multiply the points of contact of the interior substance with the circumambient fluid.

Dujardin is, moreover, of opinion in regard to the so-called eggs of Infusoria, their generative system, their organs of sense, their nerves and vessels, that none of these can be ascertained or determined with exactitude; and everything inclines him to believe that these minute creatures, although clearly endowed with a simple organization, according with their mode of life, cannot be regarded as possessing the same systems of organs as the higher tribes. The coloured points, for example, usually of a red colour, which have been regarded as eyes, cannot with propriety receive that appellation.[1]

Siebold is also opposed to the view that these vesicles or sacs are special and distinct digestive organs, and he denies the existence of any connecting canal. The *Astoma* (mouthless animalcules) he regards as nourished only by a general absorption of the surface. In the *Stomatoda* (those with evident mouths) he represents the oral orifice as continued into the interior by a sort of œsophagus, wide, and of very various form, terminating abruptly in the general loose parenchyma of the body. The food, when sought for, is drawn towards the mouth by the action of the surrounding cilia, and having been received into the mouth, enters the œsophagus, and is thence pushed onwards by a contraction of the part, in the form of a rounded globule, into the interior. After performing, during a sojourn there, a greater or less circuit, the food in the generality of *Stomatoda* is ejected through a fixed outlet, not, as Dujardin maintains, by means of a varying opening through the surface.

Wagner asserts that no one by any examination, however close, can convince himself of the actual existence of such an organization as Ehrenberg affirms. He maintains that in many Infusoria, where comparatively large bodies, such as *Naviculæ* or joints of *Algæ*, have been swallowed, no surrounding vesicle can be seen, and that these bodies will sometimes occupy the entire length and breadth of an animalcule. In the absence of mouth, nutrition seems carried on by the general surface. It may be safely inferred from these conflicting opinions that no settled or satisfactory conclusion can be formed, and that Ehrenberg's theory of polygastric structure, though it may be true, requires confirmation. The same may be said of several other organs and their functions. We have dwelt upon the digestive system at greater length than we shall do upon any other, as it forms the basis of Ehrenberg's arrangement of the animalcular kingdom.

In regard to the reproductive process among these infusorial tribes, *Monas vivipara* is regarded by Ehrenberg as the only species of the class that is viviparous. The formation of eggs is considered by that author as a fertile and frequent source of increase. Dujardin, again, views the viviparous attributes of the above-named Monas as more than doubtful, and the formation of ova in any infusorial species as by no means ascertained. He considers Ehrenberg's instances of oviposition as examples merely of *diffluence*, or the breaking up of the gelatinous substance of the animalcule into spherical atoms from want of moisture. With Siebold, he limits the reproductive process in this class to the two forms of gemmation and spontaneous fission. If this be true, then all that has been written of the ovaries, vesiculæ seminales, &c., falls to the ground. Professor Owen, however, is of opinion that the function of the nucleus of Infusoria in reproduction by spontaneous fission may be regarded as analogous to that of the essential contact of the Spermatozoon with the germ-cell in the development of the higher classes; and comparing the results in the two cases, he says it is certain "that the analogy between these phenomena in the multiplication of the parts of the germ-mass and those of the nucleus in the multiplication of monads is so close, that one cannot reasonably suppose that the nature and properties of the nucleus of the impregnated germ-cell, and that of the monad can be different." He therefore infers that the nucleus of the Polygastric animalcules is the seat of the spermatic power, though the term testes can only be figuratively applied; and he thinks that if Ehrenberg be correct in viewing the interstitial corpuscles as germ-cells, these essential parts of ova may receive the essential matter of the sperm from the nucleus, which is discharged along with them in the breaking up of the monad, which Ehrenberg regards as equivalent to an act of oviposition; and impregnated cells may thus, in Professor Owen's view, be prepared to diffuse through space, and carry the species of Polygastric animalcules to a distance from the scene of the life of the parent.[2]

Professor Weisse supposes himself to have detected reproduction by ova in *Chlorogonium euchlorum*, and maintains that the continuous observation of that species demonstrates that several of Ehrenberg's genera are nothing more than its natural development from stage to stage.[3] He describes the green matter of *chlorogonium* as developing, by spontaneous fission of itself, numerous young animalcules, which at first resemble *Uvella Bodo*, and are afterwards converted into *Chlorogonium euchlorum* and *Glenomorum tingens*. What he calls oviposition is the escape of the young by a transverse rupture of the parent, which is itself sacrificed, and disappears as a shrivelled sack. But in conformity with Thuret's views, it may be doubted whether the organic being (we shall not say creature) were really an animalcule, and not merely a thecaspore or zoospore (of an algæ), a production which so resembles the green-coloured Infusoria that Mr Pritchard states we have no means of dis-

[1] *Annales des Sciences*, 1840.
[2] *Essay on Parthenogenesis*, p. 67. Ed. 1849.
[3] *Archives für Naturgeschichte*, for 1846.

tinguishing between the two. It equally *produces* by the fission of its endochrome or green contents. M. Thuret has shown how close is the analogy between the reproductive bodies of *Confervæ* and those of the green animalcules. He regards the *Tetrasporæ*, although ranked with the *Algæ*, as of very doubtful vegetable nature. The movements of the animalcular genus *Diselmis* resemble those of zoospores, and the species equally turn to the light, under the influence of which, like algæ, they act upon the atmospheric air, disengaging a gas (oxygen?) when exposed to the rays of the sun. In a particular stage of one species, a very clear red spot was discernible, and a central globe closely resembling the amylaceous granules so common in the cells of algæ. It is the prevalence of the coloured speck in *Diselmis Dunalii* which, according to M. Joly, is the chief cause of the red colour so frequently observed over a large space of water in the Mediterranean Sea.

Whatever may be the special mode of generative increase among animalcules, their vast and rapid accumulation is as undoubted as extraordinary. Even among the Rotiferæ, direct observation has shown that a single individual will give rise to one million in ten days, and to sixteen millions in little more than a fortnight. If the children follow the footsteps of the parent, it is not easy to say what another fortnight might produce. Among the Polygastrica, the increase is still more speedy, one million having been produced from a single individual in seven days. Good and substantial food is, however, an essential condition of this rapid development; and when we consider what minute mouthfuls must suffice, we may the more easily conceive how rich a provender is spread before them in those innumerable infusions of animal and vegetable matters contained in almost all liquids. Fuchs has made some curious observations on the animalcules of cow's milk. He there finds in abundance two monadal species. He states that the blueness of milk is owing to the development and increase of an infusorial being, which he calls *Vibrio cyanogenus.* Under the name of *Vibrio xanthogenus* he defines another species, which he alleges makes milk turn yellow. Ehrenberg is of opinion that, in accordance with certain laws of nature, "living organisms," such as animalcules, may be developed in the air. The region of *atmospheric dust* is of vast extent, and ascends above 14,000 feet; and he conceives that its phenomena cannot be traced to mineral matters from the earth, nor to materials floating in space, nor to atmospheric currents, but rather bear relation to some general law of our atmosphere, in accordance with which there is a development within it of living organisms. The quantity of actual matter of this kind which falls from the air upon our earth is enormous, in consequence of the vast surface which it covers, however thinly. Meteorolites, although comparatively solid and massive, are as nothing compared with it. It has been calculated, that of atmospheric stones there fell, from 1790 to 1819, 600 cwt.; whereas a single dust-shower, which was deposited at Lyons in 1846, is estimated at 7200 cwt. As these showers have been numerous over the whole earth, Ehrenberg asks, how many millions of tons weight of animalcular beings have fallen since the time of Homer? Important results have been deduced from the examination of the animalcular dust which falls at sea, as well as on land, in the determination of the direction of atmospheric currents.[1]

Whatever defects may exist in Ehrenberg's system of arrangement, in consequence of some fallacies in his mode of viewing the organic structure and physiological functions of these extraordinary beings, there is no doubt that we owe to him many important observations and discoveries. He has especially pointed out the great influence exercised by these minutest of beings in the actual structure of the solid crust of the earth. He has satisfied both himself and others that the calcareous rocks of Syria and of Central North America contain densely crowded masses of small Polythalamiæ, several species of which, from the limestone of the New World, are identical with those of the European chalk. He has found the plastic marl of Ægina to consist of organisms, several of which pertain to the animalcules of the chalk. Lüneberg Heath is described as a great bed of Infusoria; and one of the largest deposits yet known is near Berlin, in which it is remarkable that species still living, but not hitherto discovered at the surface of the soil, are found among the fossil species. Quekett has recorded that an infusorial stratum, twenty feet in thickness, underlies the city of Richmond in Virginia, and that several of the forms agree specifically with those found in the North Sea. Abundance of microscopic shields belonging to marine Infusoria (both the siliceous-shelled Polygastrica, and the calcareous-shelled Polythalamia) occur in the deposits of the Elbe, near Hamburgh and Gluckstadt. Similar results were yielded by the mud of the Scheldt, and by marine deposits on the shores of the North Sea and Baltic. Ehrenberg has well shown the enormous proportionate extent and intensity of life in the highest latitudes both north and south, and at the greatest attainable depth of the ocean.

So prodigious are the aggregations of these smallest forms of life, that they have actually raised, and are still raising, vast tracts of land from the bottom of the sea. Our antarctic voyagers have informed us that the waters of the ocean, between the parallels of 60° and 80° south latitude, are of a pale ochrey-brown colour, in consequence of the enormous accumulation of these the frailest and yet least perishable parts of creation. Their death and decomposition have, we know not in the course of how long a period, actually produced a submarine bank or deposit of such vast dimensions, as to occupy an area of 400 miles long by 120 wide, flanking, as Dr Joseph Hooker has informed us, the entire length of the Victoria Reef.

Among the more singular localities of the Infusoria may be mentioned, not only meteoric dust, already noticed, but volcanic ashes, and other precipitations from the atmosphere. Ehrenberg has also shown that the blood-red spots which, to the terror of the superstitious, sometimes appear on bread and other substances, are occasioned by the surprisingly rapid development of an animalcule called *Monas prodigiosa.* He further supposes that one of the miracles in Egypt, recorded by the great lawgiver of the Jews, of the turning of water into blood, was produced, humanly speaking, by means of *Euglena sanguinea* (*Ascaria viridis* of Müller, for it is sometimes *green*), or by the use of another species called *Astasia hæmatodes.*

The character of the lorica, or somewhat shelly covering, differs in its nature and composition in the different genera; being in some entirely siliceous, in others, composed of lime, combined with carbonic acid as a carbonate, with a portion of the oxide of iron. As in many of the smaller genera it is difficult to ascertain whether they are enclosed in a lorica or not, we may here state Mr Pritchard's mode of ascertaining the existence of that character. Having obtained some specimens, say of the family *Cryptomonas,* he places a drop of water containing them in a compressor or crush-box, mixing a little colouring matter with the water. If the species are loricated, a clear transparent ring will be observed under the microscope, encircling the animalcules, and seeming to keep them separate from the fluid in which they are immersed.[2] Should this test prove unsatisfactory or insufficient, then the cover of the box may be pressed down, so as to

[1] A complete history of showers of meteoric dust will be found in Ehrenberg's *Passat-Staub und Blut-Regen,* of which a brief abstract is given in Pritchard's *Infusorial Animalcules,* p. 89.

[2] *Infusorial Animalcules,* p. 13.

Animalcule.

crush the specimens, when the coloured fluid will enter and surround their bodies; and, by a proper and expert management of the illumination of the microscope, the broken edges of the lorica will become visible.

The unfixed condition of opinion regarding infusorial animalcules is curiously indicated by the fact, that many careful and assiduous observers, such as Bauer, Leuckhart, Agassiz, and Reichenbach, deny the very existence of these creatures as a *class*, and maintain that they are mostly the embryonic forms of other and more highly organized beings. We doubt not that the opinion expressed in our preceding article, that our knowledge of this "invisible world" is in its infancy, is still correct, and that as the telescope brings forth stars from their nebular darkness, so the further the light of our microscopic knowledge penetrates into the obscure depth of the animalcular kingdom, the more clearly we shall have its now component parts resolved into definite forms of another nature than we at present suppose them. But that they are all merely embryonic forms, is doubtless a most visionary view, as no reason can be assigned *a priori* that beings, however small, are either uncertain or transitional, or that completion and finality of form are in any way inconsistent with excessive minuteness. One lesson may assuredly be drawn from the difficulties which beset the subject,—to avoid dogmatism, and bear in mind how unable we often are to solve the question, "What is truth?" But the extraordinary mutability of form and outward aspect of those frail creatures is no argument against their fixity of specific character within a certain range of variation, however wide. We know how different are the individuals even of some of the higher species from each other, under different circumstances, and at different stages of their life; but when once under our eye, they may be made cognizable to the senses of an observant person, under all their phases; that is, they may be identified with certainty from time to time. But with many animalcular beings it is not so. We see them once, as the astronomer may see some "bright particular star;" but we cannot calculate their erratic and changing course of life; and thus they may be either seen again no more for ever, or be observed under an altered aspect by another observer, and recorded with new characters under a different name. These, and such-like causes, may easily be conceived to operate disadvantageously against our speedy acquirement of assured knowledge regarding the animalcular tribes. But by means of patient and discriminating investigation on our own parts, a candid consideration of the observations of others, and an unbiassed record of whatever has been clearly ascertained, there is no reason why the subject should not be gradually advanced so as to take rank with other branches of a less ambiguous nature. The general reader will not wonder at the state of uncertainty which still pervades our notions of many animalcules, when we mention, as an example of extreme minuteness, *Monas crepusculum*, of which the number occupying the space of a grain of mustard seed, one-tenth of an inch in diameter, has been calculated at *eight millions!*

Ehrenberg's great group of polygastric animalcules is primarily divided into *Anentera* (such as do not possess a true alimentary canal), and *Enterodela* (or such as are furnished with an alimentary canal). Here we are met by a noted antagonistic observer upon the very threshold.

"Recent investigations," says M. Agassiz, "upon the so-called Anentera, have satisfactorily shown, in my opinion, and in that of most competent observers, that this type of Ehrenberg's *Polygastrica*, without gastric cavities, and without an alimentary tube, are really plants belonging to the order of algæ in the widest extension of this group; while most of the monad tribe are merely moveable germs of various kinds of other algæ. As for the Enterodela—most of them, far from being perfect animals, are only germs in an early stage of development. The family of *Vorticella* exhibits so close a relation with the Bryozoa (cilio-brachiate polypes), and especially with the genus *Pedicellina*, that I have no doubt, that wherever Bryozoa should be placed, *Vorticella* should follow, and be ranked in the same division with them. The terminal group of Infusoria, *Bursaria*, *Paramecium*, and the like, are, as I have satisfied myself by direct investigation, germs of fresh-water worms, some of which I have seen hatched from eggs of *Planaria* laid under my eyes."[1]

Not only are authors on our present department opposed to each other, but (a rarer case) they seem in some instances to have no great confidence even in themselves. Thus M. Dujardin, one of the most trustworthy of the modern microscopic observers, after giving in a tabular form the characters of the groups which constitute the family *Monadina*, sums up by stating: "But these generic distinctions are entirely artificial, and simply intended to facilitate the naming of Infusoria one may meet with in such and such infusions, and which, when better known, may prove in some instances to be but varieties of a single species."[2]

The preceding notices will suffice to show the still unsettled state of opinion regarding animalcules, and that Ehrenberg's system, although of great importance to the discriminating student, is not to be adopted implicitly as an assured exposition of the truth. We cannot here exhibit more of his arrangement than a compendious view of the family groups,—referring for details of genera and species to the work itself,[3] and to others, with a list of which we shall conclude these supplementary observations.

Tabular View of Ehrenberg's Arrangement.

					Family.
Anentera, without true Alimentary Canal.	No foot-like appendages. *Gymnica.*	Form of body constant.	Self-division complete.	illoricated, or without shell	Monadina.
				loricated, or shelled	Cryptomonadina.
			Self-division incomplete.	illoricated	Hydromorina.
				self-division general and globular	Volvocina.
				self-division unilateral (filiform) — illoricated	Vibrionia.
				self-division unilateral (filiform) — loricated	Closterina.
		Form of body variable.	illoricated		Astasiæa.
			loricated		Dinobryina.
	With variable foot-like processes. *Pseudopoda.*	illoricated			Amœbæa.
		loricated	Foot-like processes, compound		Arcellina.
			Foot-like processes, simple		Bacillaria.
	Hairy. *Epitricha.*	illoricated			Cyclidina.
		loricated			Peridinæa.

[1] *Annals of Natural History*, vol. vi. p. 156, 1850. Similar observations had been made by Mr Girard, who states that *Kolpoda cucullus* is an embryonic stage of a species of Planaria.

[2] *Hist. des Infusoires*, p. 273.

[3] *Die Infusionsthierchen als vollkommene organismen. Ein Blick in das tiefere Leben der organischen Natur.* Atlas mit 64 illuminirten Kupfertafeln, gr. fol. Leipzig, 1838.

				Family.
ENTERODELA, with an Alimentary Canal.	One orifice. *Anopisthia.*	illoricated		VORTICELLINA.
		loricated		OPHRYDINA.
	Two opposite orifices. *Enantiotreta.*	illoricated		ENCHELIA.
		loricated		COLEPINA.
	Orifices situated obliquely. *Allotreta.*	illoricated	with proboscis, no tail	TRACHELINA.
			anterior mouth, a tail	OPHRYOCERCINA.
		loricated		ASPIDISCINA.
	Orifices abdominal. *Catotreta.*	illoricated	locomotive cilia	KOLPODEA.
			locomotive organs	OXYTRICHINA.
		loricated		EUPLOTA.

We shall conclude by observing that some years ago an idea became prevalent that animalcules might be *manufactured* by means of galvanism. The results of some of the experiments proved too much, for the creatures when examined were found to belong, not to the Infusorial tribes, but to the Arachnides, a class more highly organized than even Insects.[1] That the earlier naturalists, labouring under the disadvantage of imperfect glasses should have made mistakes is not surprising; but we read with wonder, in the year 1833, Dutrochet's statement that all the globular and elliptical Infusoria were merely vesicles set in motion by streams of electricity, and so might be artificially produced. In the following year Cagniard Latour declared that he had manufactured animalcules by means of carburetted hydrogen. But M. Audouin's examination proved that they were *Entomostraca*, and that the method employed in their production was fallacious. The following is Ehrenberg's account of some curious experiments on these imaginary productions by Professor Bondsdorff, communicated to the German Naturalists' Association in 1834. If a solution of chloride of aluminum be dropped into a solution of potassa, by the attenuate solution of the aluminum in the excess of alkali, an appearance will be given to the drop of aluminated matter, by the chemical changes and reactions which take place, as if the *Amœba diffluens* were actually present, both as to its form and evolutions, and it will *seem to be alive.* Such appearance, adds Bondsdorff, bears the same relationship to the real animalcule as a doll or figure moved by mechanism does to a living child.

The English reader will consult with advantage Mr Pritchard's *History of Infusorial Animalcules, living and fossil:* new edition, enlarged, Lond. 1852. A great mass of useful information is there collected, and Ehrenberg's system is given in detail. F. T. Kützing's *Die Bieselschaligen Bacillarien od. Diatomeen,* 1844, is an excellent work. Dujardin's has been already named in full, as perhaps the best systematic work we have on animalcules at the present time. Mr Ralfs' recent monograph on the *British Desmidieæ* (Lond. 1848) will be found indispensable; as also the Rev. William Smith's *Synopsis of the British Diatomaceæ,* vol. i. Lond. 1853.

The following is a list of papers published in the *Annals of Natural History,* from which much useful information will be gained:—On the existence of Infusoria in Plants; by Professor Morren; vol. vi. p. 344. On the Sacculi of Polygastrica; by Dr J. W. Griffiths; vol. xi. p. 438. On the production of Infusoria in the Stomachs of Herbivorous and Carnivorous Animals; by MM. Gruby and Delafond; vol. xiii. p. 154. On Microscopic Life in the Ocean; by Professor Ehrenberg; vol. xiv. p. 169. Abundant Occurrence of rare Infusoria in the Scallop; by H. Lee; vol. xv. p. 371. Microscopical Examination of the Chalk and Flint of the south-east of England; by Dr Mantell; vol. xvi. p. 73. On the Organization of the Polygastric Infusoria; by C. Eckhard; vol. xviii. p. 433. On Conjugation in the Diatomaceæ; by G. H. K. Thwaites; vol. xx. pp. 9 and 343. On the Siliceous Polycystina of Barbadoes; by Professor Ehrenberg; vol. xx. p. 115.

The following papers are from the new series of the *Annals:*—On the British Lagenæ; by W. C. Williamson; vol. i. p. 1. On the Diatomaceæ; by G. H. K. Thwaites; vol. i. p. 161. On a new British Species of Campylodiscus; by W. C. Williamson; vol. i. p. 321. Notes on Diatomaceæ; by Professor Dickie; vol. i. p. 322. On Fossil Diatomaceæ in Aberdeenshire; by Professor Dickie; vol. ii. p. 93. On a Diœcious Rotifier; by T. Brightwell; vol. ii. p. 153. On the colour of a Fresh-Water Loch; by Professor Dickie; vol. iii. p. 20. On the Mode of Growth in Oscillatoriæ; by J. Ralfs; vol. iii. p. 39. Observations on Recent Foraminifera; by W. Clark; vol. iii. p. 380. On two new species of Floscularia; by Dr W. M. Dobie; vol. iv. p. 233. On the Development of Trichodina pediculus; by J. T. Arlidge; vol. iv. p. 269. On the Conjugation of Closterium Ehrenbergii; by the Rev. W. Smith; vol. v. p. 1. On Deposits of Diatomaceous Earth on the shores of Lough Morne, county Antrim; by the Rev. W. Smith; vol. v. p. 121. On Nyctotherus, a new genus of Polygastrica; by Dr Leidy; vol. v. p. 156. On the Recent Foraminifera; by W. Clark; vol. v. p. 161. On the Nostochineæ; by J. Ralfs; vol. v. 321. On Asplanchna priodonta; by P. H. Gosse; vol. vi. p. 18. Notes on the Diatomaceæ, with descriptions of the British species included in the genera Campylodiscus, Surirella, and Cymatopleura; by the Rev. W. Smith; vol. vii. p. 1. On three new species of Animalcules; by J. Alder; vol. vii. p. 426. On the Germination of the Spore in the Conjugateæ; by the Rev. W. Smith; vol. viii. p. 302. On the Cell-Membrane of Diatomaceous Shells; by J. W. Bailey; vol. viii. p. 157. Remarks on Dickieia; by J. Ralfs; vol. vii. p. 204. Catalogue of the Rotifera found in Britain, with descriptions of five new genera, and thirty-two new species; by P. H. Gosse; vol. viii. p. 197. On Chantransia; by J. Ralfs; vol. viii. p. 302. Notes on the Diatomaceæ, with Descriptions of the British Species, included in the genus Pleurosigma; by the Rev. W. Smith; vol. ix. p. 1. (J. W.)

[1] For example, the animal obtained by Mr Crosse by means of galvanism was an *Acarus.* It was afterwards stated to be a well-known species, common in houses, and not unlikely to make its accidental way into a philosophical apparatus.

ANIMATION signifies the communication of life to an animal body. A fœtus was formerly said, in a legal sense, to be animated when it was perceived to stir in the womb; but this doctrine is exploded, animation being now dated from the moment of conception. See ABORTION.

ANIME, a resin exuding from the trunk of a large American tree, called by the Indians *courbaril* (a species of HYMENÆA). This resin is of a transparent amber colour, a light agreeable smell, and little or no taste. It dissolves entirely, but not very readily, in rectified spirit of wine; the impurities, which are very often in large quantity, remaining behind. The Brazilians are said to employ anime in fumigations for pains and aches proceeding from cold: with us, it is rarely, if ever, made use of for any medicinal purpose.

ANIMETTA, among *Ecclesiastical Writers*, denotes the cloth wherewith the cup of the eucharist is covered.

ANIO, or ANIEN, the modern TEVERONE, one of the most considerable tributaries of the Tiber, rises in the Apennines, about three miles above Trevi; and flowing first in a north-western, and afterwards in a south-western direction, joins the Tiber three miles above Rome. In its course it receives several small rivulets, among which is the Digentia of Horace, now the Licenza; and at Tibur it forms a beautiful cascade, originally the work of the Romans. The waters of the cascade are now carried through a tunnel constructed in 1834. Rome was supplied from this river, on account of the purity of its water, by means of two aqueducts, called the *Anio vetus* and *Anio novus*.

ANISE, an umbelliferous plant of the Linnæan genus *Pimpinella*. The seed is a very agreeable aromatic, and is much used in the confectionary art, in perfumery, and in medicine. It is a product of China, Egypt, and some other countries, and is cultivated in Germany, Spain, and Malta. The best comes from Alicante in Spain.

ANISO (from ἄνισος, *unequal*), a prefix to several terms in natural history, implying some kind or degree of inequality of parts: as, for example, *aniso-dactylous* birds, *i.e.*, having toes of unequal length; *aniso-dynamous* plants, *i.e.*, having flowers which grow with more vigour on one side of their axis than on the other; *aniso-stemonous* flowers, *i. e.*, having a greater or a less number of stamens than there are sepals in the calyx.

ANJAR, a fortified town of Hindustan, and the capital of a district of the same name in the native state of Cutch. The country is dry and sandy, and depends entirely on irrigation by means of wells. The town is situate nearly ten miles from the Gulf of Cutch. It suffered severely from an earthquake in 1819, which destroyed a large number of houses and occasioned the loss of several lives. One half of the town situated on low rocky ridges suffered comparatively nothing. In 1820 the population was estimated at 10,000.

The town and district of Anjar were both ceded to the British in 1816, but in 1822 they were again transferred to the Cutch government in consideration of an annual money payment. Subsequently it was discovered that this obligation pressed heavily upon the resources of the state, and in 1832 the pecuniary equivalent for Anjar, both prospectively and inclusive of the arrears which had accrued to that date, were wholly remitted by the British government. Lat. 23. 6. Long. 70. 3. (E. T.)

ANJENGO, a small seaport town and fortress of Hindustan, in Travancore, nearly encircled by a deep and broad river, at the mouth of which it is situated. The fort was built by the English in 1684, and it was retained till 1813, when the factory was abolished on account of the useless expense attending it. Anjengo is infested with snakes, scorpions, and centipedes; those animals finding shelter in the matted leaves of the cocoa-tree, with which the houses are mostly thatched. Here and at Cochin are manufactured, of the fibres of the Laccadive cocoa-nut, the best coir cables on the Malabar coast. The exports are pepper, coarse piece goods, coir, and some drugs.

ANJOU, a province and duchy of France before the Revolution, bounded on the east by Touraine, on the south by Poitou, on the west by Bretagne, and on the north by Maine. It now forms the department of Maine and Loire, and parts of Sarthe, Mayenne, and Indre and Loire. It is 90 miles in length, and 60 in breadth. Through this province runs the Loire, which divides it into two parts. Angers was its capital.

ANKER, a liquid measure at Amsterdam. It contains about $8\frac{1}{2}$ English imperial gallons.

ANKLAM, a circle in the government of Stettin in the Prussian province of Pomerania. It extends over 192 geographical square miles, and contains one city and 54 villages. In 1849 the number of inhabitants was 28,507. The land is level, with extensive woods, and about twenty fresh-water lakes, the largest of which is Ahlbeckr. The feeding of cattle and growing of corn are the chief objects of agriculture; besides which some hops and tobacco, and much flax, are grown The woods afford much profitable employment, and furnish charcoal to the iron-works in Pomerania. The capital of the circle is of the same name. It is situated on the river Peene, and is now without fortifications. In 1849 it contained three churches, three hospitals, 725 houses, and 9111 inhabitants. By means of the river it carries on some trade; and it has manufactures of cloth, hosiery, tobacco, snuff, and leather. Long. 13. 35. E. Lat. 53. 47. N.

ANKOBAR, or ANKOBER, the capital of the new kingdom of Shoa, in the province of Efat, and southern part of Abyssinia, Lat. 9. 34. 33. N. and Long. 39. 53. E., 372 miles travelling distance south-west from the seaport of Tajarrah, and 300 south-east of Gondar. It is built on the sloping side of a mountain 8200 feet above the level of the sea, and surrounded by an Alpine country. Pop. about 5000.

ANN, or ANNAT, in *Scottish Law*, is half a year's stipend which the act 1672, c. 13, gives to the executors of ministers of the Church of Scotland, over and above what was due to the minister himself for his incumbency. As it is a mere gratuity given by the law to those whom, it is presumed, the deceased could not sufficiently provide for, so it is neither assignable by him during his life, nor attachable by his creditors after his death.

Annats is applied in English law to the annual income of an ecclesiastical living, the first fruits paid originally to the pope by the successor of a deceased bishop, abbot, or parish-clerk. At the time of the Reformation, they were vested in the king; but in Queen Anne's reign were restored to the church, and appropriated to the augmentation of small livings.

ANNA, ANA, or ANAH, a town of Arabian Irak, or pachalic of Baghdad, which extends five or six miles along the western bank of the Euphrates. It consists of a single street built on both sides. The houses are of stone, two stories high, and separated from each other, as in other eastern towns, by beautiful gardens filled with fruit-trees, bearing lemons, oranges, citrons, quinces, figs, dates, pomegranates, and olives. It is an open and defenceless place, and in 1807 was plundered by the Wahabees, who massacred the greater part of the inhabitants, and set the town on fire; after which they retreated with their plunder, carrying into captivity many women and children. The inhabitants, previous to this calamity, are said to have been more polished than those in the neighbourhood, and to have consisted chiefly of Arabians, who were, however, addicted to their usual vocation of robbery when any opportunity presented. Pop. about 2000. 260 miles east of Damascus; 220 south-east of Aleppo. Long. 41. 47 E. Lat. 34. 10. N. It is the ancient *Hadith*.

ANNA *Comnena*, daughter of the Emperor Alexius Com-

nenus I., was not more distinguished by her elevated rank than by her mental qualifications. Her superiority of mind began early to display itself. Despising the effeminacy and voluptuousness of the court in which she was educated, she directed her attention to literary pursuits. Indulging her favourite studies, she solicited the acquaintance of the more eminent philosophers of that period.

But the pursuits of literature did not induce her entirely to abandon society; she gave her hand to Nicephorus Briennius, a young nobleman of a respectable family. This accomplished woman was, however, actuated by unjustifiable ambition; and during the last illness of her father, she united with the Empress Irene in attempting to prevail upon that monarch to disinherit his own son, and give the crown to her husband. The affection and virtue of the father prevailed over female address and intrigue. But the ambition of Comnena was not subdued. She entered into a conspiracy to depose her brother; and when her husband displayed timidity and hesitation in this unjust enterprise, she exclaimed that "nature had mistaken their sexes, for he ought to have been the woman."

Either through the vigilance of her brother or the timidity of her husband, the treasonable plot was discovered, and Anna punished with the confiscation of all her property. It was afterwards, however, restored to her by the generosity of her brother. Ashamed of her base conduct, she retired from court, and never more possessed any influence there. Disappointed ambition took shelter among the walks of literature, and she employed her solitude in writing the history of her father's reign. This production is still extant, and forms a part of the celebrated collection of the *Byzantine Historians*. The stores of rhetoric are ransacked to embellish this work, and every effort made to enrich it with science; but its general character is rather that of an apology than of an impartial narrative. It must, however, be acknowledged that she is not more partial than many other Latin historians, and that her history contains many valuable facts and observations. The best edition is by Schopen, 2 vols. 8vo.

ANNA *Ivanovna*, Empress of Russia, daughter of Ivan, brother of Peter the Great, was born in 1693, and married in 1710 to the Duke of Courland, who died the following year. After the death of Peter II., in 1730, the supreme council of the empire offered the vacant throne of Russia to Anna on the following conditions. She was to govern according to the decisions of the supreme council, and she was not allowed without its consent either to declare war or to conclude peace, to impose new taxes, to grant any important office of the state, to dispose of crown lands, to contract a matrimonial alliance, or to nominate a successor to the throne. She was also not to punish any noble, or to confiscate any one's property without a legal sentence. Anna signed these conditions without any opposition; but after her arrival at Moscow, a numerous party jealous of the authority which this constitution, imitated from that of Sweden, gave to the supreme council, or rather to the families of the Princes Dolgorouki and Galitzin, of whose members it was chiefly composed, petitioned the empress to assume the autocracy of her predecessors. Anna immediately complied with this request, and the framers of the constitution were either banished to Siberia, or perished on the scaffold. Russia was governed during the whole reign of Anna by her favourite Biren, who was made by her influence Duke of Courland, in a most tyrannical and oppressive manner, so that, according to Russian authorities, twenty thousand victims of Biren's tyranny perished during Anna's reign of six years; and amongst them persons belonging to the highest ranks in the country. The principal events of Anna's reign were the voluntary restoration, in 1732, to Shah Nadir of the Russian provinces, Shirvan, Ghilan, and Mazanderan, acquired by Peter the Great, but which caused more expense than they gave of revenue to Russia; a Chinese embassy at St Petersburg, the only one that was ever sent to Europe; the assistance given to the Elector of Saxony and King of Poland, Augustus III., against his competitor Stanislaus Leszczinski, supported by France; a Russian army sent to the assistance of the Emperor Charles VI. against France; a war with Turkey from 1736 to 1739, which, notwithstanding several successful campaigns, gave no advantage to Russia at the conclusion of peace; and an advance made into central Asia by the establishment of the Russian protectorate over the khan of the Kirguizes, who, with the assistance of Russian officers, conquered Khiva, but fortunately for our present interests in the East, did not maintain himself there.

Anna died in 1740. Her reign is considered as a period of transition from the old Muscovite semibarbarian manners to the polish though not the civilization of the West. (V. K.)

ANNA *Perenna*, an ancient Italian divinity, regarded as the giver of life, health, and plenty. In later times she was identified with Anna the sister of Dido, who threw herself into the Numicius, and was thenceforth worshipped as the nymph of that river. See Ovid. *Fast.* iii., Virg. *Æneid.* iv., Macrob. *Sat.* i. 12.

ANNABERG, a city on the mountains in the bailiwick of Wolkenstein, circle of Erzgebirge, and kingdom of Saxony. It is 1820 feet above the level of the sea, in the midst of a mining district, which yields silver, tin, and cobalt. In 1849 it contained 677 houses, and 9437 inhabitants, chiefly employed in manufacturing tapes, lace, sewing silk, besides many other articles. Lat. 50. 35. N. Long. 13. 0. E.

ANNAGH, an island about five miles in circumference, on the west coast of Ireland, between the isle of Achill and the mainland of the county of Mayo. Long. 9. 49. W. Lat. 53. 58. N. There is a small village of the same name in the county of Cork, five miles from Charleville.

ANNALS (*Annales*, from *annus* a *year*), a term commonly applied to a concise and plain kind of narrative of historical facts digested in the order of time, each event being arranged under the particular year in which it happened. Although this style of composition does not necessarily exclude the casual observations of the writer, episodes or formal digressions are incompatible with the brevity characteristic of annals: while history, on the other hand, comprises not only the narrative and exposition of facts, but also the writer's observations on actions, motives, causes, and consequences, in general; thus affording ample scope for illustration and embellishment. Annals may be said to constitute the essence of history, since they are the elements or materials of which it is composed.

We are told by Cicero (*de Oratore*, ii. 12), that from the earliest period of the Roman state the Pontifex Maximus, in order to preserve the memory of events, used to write down the public transactions of each year on a whited tablet, which he exposed in an open place at his house, that the people might come and read it; hence, in his time, these records were called *annales maximi*. The greater part of the annals composed by the Pontifex previous to the capture of Rome by the Gauls, perished at that time in the burning of the city, B.C. 390. These records, which appear to have been of a very meagre nature, were probably the same as the *Commentarii pontificum* cited by Livy. Commentarii was also used to denote the memoirs which an individual wrote concerning his own actions. Thus Julius Cæsar designated the celebrated account he wrote of his own campaigns with the unassuming title of Commentaries. It may be observed that this was a general term for any kind of notes or simple memoranda.

The practice of compiling annals was continued until the pontificate of P. Mucius Scævola and the time of the Gracchi, when its omission was a circumstance of less im-

portance, as a literature had been formed. After the pontifices ceased to compose annals, many other persons, both among the Greeks and the Romans, began to draw up historical accounts of public affairs, in which they imitated the condensed and unadorned style of the pontifical records. Cicero, in speaking of these annalists, says—"*unam dicendi laudem putant esse brevitatem.*"

The distinction, however, between annals and history properly so called, is a subject that has exercised the ingenuity of many distinguished critics, and given rise to more discussion than its intrinsic importance perhaps deserved. Aulus Gellius, in the *Noctes Atticæ* (v. 18), endeavours to demonstrate, on the authority of the grammarian Verrius Flaccus, that the derivation of the word history from ἱστορεῖν (*inspicere*, or *to inquire in person*), would seem to indicate that history is an account of events which happened during the time of the writer. Annals, again, he distinguishes as a relation of the events of earlier times, arranged under the respective years in which they occurred. Similar to this is the well-known definition given by Servius (*ad Æneid.* i. 373). This is the explanation that Gronovius has expressly declared to be satisfactory to himself; and it is the one which the learned Grotius has consented to follow in his *History of the Netherlands*, since he divides that great work into Annals and History accordingly. The *Historiæ* and the *Annales* of Tacitus would seem at first sight to countenance such a distinction, as the former work is occupied with the transactions of his own time, while the latter is devoted to the events of an earlier period. But, on the other hand, it is by no means certain that Tacitus made any such distinction between them; and it is more probable that he gave the title of *Annales* to both these works, if, indeed, he used either of the terms. It seems by no means improbable that the title of *Annales* was given to that work after the time of Tacitus; and, indeed, there seems to be no peculiar propriety in the designation simply because the events are arranged in the order of time, since that would render it equally applicable to the books of Livy, or Cæsar's Commentaries. The concise vigorous style of the *Annales* may have been one cause of their receiving that title; yet brevity was inseparable from the style of Tacitus, a peculiarity conspicuous even in the *Historiæ*; and in reference to which Montesquieu has remarked—"Tacitus knew everything, and therefore abridged everything." In the so-called *Annales* (iii. 65, iv. 71), Tacitus explains that he was prevented by the plan of the work from entering upon details in general, or anticipating the order of events; and this has given the *Annales* a greater degree of brevity than appears in the *Historiæ*. With respect to these titles, however, there is no direct evidence to prove that such a distinction as that mentioned by Aulus Gellius and Servius was recognised by writers contemporary with Tacitus, and it may fairly be presumed to have been the invention of a later period.

If Tacitus really gave no definitive title to either of the works in question, such omission, perhaps, was not without precedent. Niebuhr, in his ingenious but somewhat fanciful disquisition on the Distinction between Annals and History, concludes his remarks by the inquiry whether the title *Historiarum ab urbe condita* was the original designation of the books of Livy; and he conjectures that the historian may possibly have used neither *historiæ* nor *annales*, since Diomedes, Priscian, and other grammarians never cite otherwise than *Livius ab urbe condita libro*;—and he suggests that the strangeness of the inscription may have occasioned the filling up of the blank.—(See *Cambridge Philological Museum*, No. vi. 1833, p. 670; translated from the *Rheinisches Museum.*)

The high antiquity of the annalistic form of writing requires no demonstration; and perhaps there are few nations that possess no such memorials of their early history. The Chinese, whose veracity in matters of antiquity is frequently questionable, affirm that their annals date from so remote a period as 3000 years or more before the Christian era.

Independently of the consideration that annals are the basis of all history, there is one point of view in which they must be regarded as possessing a high degree of political importance. Knowledge being confessedly the basis of constitutional liberty, veritable annals may be said to be a record of facts unperverted by the bias of the historian; by means of which the people are to be guided and instructed, in order that they may appreciate the advantages they already possess, and be led to maintain inviolate those rights for which their progenitors have toiled and suffered.

ANNAMABOE, an English factory and fort on the Gold Coast of Africa, in Lat. 5. 5. N. Long. 1. 15. W. In 1808 it was gallantly defended by twenty-four English soldiers against 15,000 Ashantees, who destroyed the negro town and butchered the inhabitants.

ANNAN, a royal burgh and parish of Scotland, in the county of Dumfries, on the river of the same name, about two miles above its junction with the Solway Firth. The river is crossed by an elegant bridge of three arches, built in 1824. It has a good harbour, and the highest tides rise 21 feet. In 1851 the population of the town amounted to 3426. The people are chiefly engaged in the coasting trade, ship-building, gingham-weaving, and the curing of bacon and hams for the Newcastle and London markets. A cotton spinning manufactory has been long established in the town, giving employment to between 80 and 100 persons of different ages. The salmon fishery, which in former years was very productive, has much fallen off. Among the public buildings is a handsome academy, built and endowed by the heritors and the town-council: it is conducted by a rector and two masters, and is in a very flourishing state. Annan unites with Dumfries, Kirkcudbright, Sanquhar, and Lochmaben, in sending a representative to parliament. The environs are very inviting; and few places are more beautiful than the river and its finely-wooded banks, for eight or ten miles above the town. It had formerly a castle, built by the Bruces after they became lords of Annandale. Distance from Dumfries 14 miles, from Edinburgh 79.

The River Annan, on which the town stands, rises in the Hartfell Mountain on the confines of the counties of Peebles and Dumfries, and flowing southward, falls into the Solway Firth after a course of 30 miles. It abounds with trout and salmon. The stewartry or district of Annandale, of which Lochmaben castle was the chief fortalice, is a fertile vale, 30 miles long and about 16 miles broad. From its vicinity to England, and the continual incursions and predatory wars of the borderers, the greater part of it was uncultivated and common; but since the beginning of the last century all these wastes and commons have been subdivided and brought into culture, and the country has assumed a new appearance, which may be ascribed not only to the division of the commons, but likewise to the improvement made on the roads.

Annandale formed a part of the Roman province of Valentia; and it abounds with Roman stations and antiquities. The Roman camps at Birrens in Middlebie, on the hill of Birrenswark, and at Torwood Muir in Dryfesdale, are still nearly entire, and their form is preserved; and the traces and remains of a military road are yet visible in different parts of the country. The ruins of the house or castle of Auchincass, in the neighbourhood of Moffat, once the seat of that potent baron Thomas Randolph, earl of Murray, lord of Annandale, and regent of Scotland during the minority of David II., cover above an acre of ground, and even now convey an idea of the plan and strength of the building. The ancient castle of Comlongan, formerly belonging to the Murrays, earls of Annandale, and now to the earl of Mansfield, is still in a tolerable state of preservation; but except

Annand || Anne.

this castle, and that of Hoddam, most of the other old fortalices and towers are now taken down or in ruins.

ANNAND, William, Dean of Edinburgh, the son of William Annand, minister of Ayr, was born at Ayr in 1633. Five years after, his father was obliged to quit Scotland with his family, on account of their adherence to the king and to the Episcopal form of church government. In 1651 young Annand was admitted a scholar in University College, Oxford; and in 1656, being then bachelor of arts, was appointed preacher at Weston on the Green, near Bicester in Oxfordshire. After he had taken the degree of master of arts, he was presented to the vicarage of Leighton-Buzzard in Bedfordshire, where he distinguished himself by his edifying manner of preaching. In 1662 he went to Scotland as chaplain to John Earl of Middleton, the king's high commissioner to the parliament of that kingdom. In the end of the year 1663 he was instituted to the Tolbooth Church at Edinburgh, and from thence was removed, some years after, to the Tron Church of that city. In April 1676 he was nominated by the king to the Deanery of Edinburgh; and in 1685 he was made doctor of divinity in the university of St Andrew. He wrote several books on religious and ecclesiastical subjects. He died on the 13th of June 1689, and was interred in the Greyfriars Church, Edinburgh.

ANNAPOLIS, the capital of Maryland, in North America. It stands on the River Severn, two miles from its entrance into Chesapeake Bay, and is a small but well-built town, with a handsome state-house, &c. Population in 1850, 4198. Lat. 38. 58. 35. N. Long. 76. 33. W.

Annapolis, a county and town of Nova Scotia, on the Bay of Fundy. The town was the first French settlement in that part of the world; but was finally captured by the English in 1710, and ceded to them at the peace of 1713. The town is in Lat. 44. 40. N. Long. 65. 37. W. It is neither populous nor flourishing, but falling into decay. The harbour, however, is good.

ANNE, Queen of Great Britain and Ireland, was born on the 6th of February 1664. She was the second daughter of James Duke of York, afterwards James II. She was only seven years old when her mother, Anne Hyde, died, having previously professed adherence to the Church of Rome, a step which was immediately imitated by her husband. The Duke, however, had to allow his daughters, the princesses Mary and Anne, to be brought up as Protestants; and Anne always continued to be attached, zealously and even bigotedly, to the Church of England. In her twentieth year she was married to Prince George, the brother of the King of Denmark. In the establishment then formed for her, a place was given, on her own earnest desire, to her early playfellow Lady Churchill, afterwards Duchess of Marlborough; and this ambitious and imperious woman, acquiring rapidly an irresistible authority over the feeble mind of the princess, thenceforth ruled her absolutely for more than twenty years. Not long afterwards, when the Duke of York had become king, he made repeated attempts to convert the princess Anne to his own creed: he engaged that, if she would become a Roman Catholic, she should be placed in the line of succession to the throne before her elder sister Mary. Prince George appears to have received those overtures favourably; but he, an indolent and good-natured man, who cared for nothing but good eating and field-sports, never had any influence over his wife. She remained firm in her Protestantism, lived in retirement during the whole of her father's reign, and did not allow her opinions or feelings any further vent than that which they found in her private correspondence with the Princess of Orange. When, in 1688, James's queen gave birth to a son, the sisters took a lively interest in the suspicions and inquiries that arose: and Anne was easily led to believe that the child was supposititious; though later in her life she must have been convinced that he was really her brother. Before the landing of the Prince of Orange, Prince George was pledged to join him; and his wife and Lady Churchill abandoned King James on the first opportunity.

Anne.

From the Revolution till the death of William III., Anne's way of life was as quiet and obscure as it had been during the reign of her father. She did, indeed, on the prompting of her favourite, acquiesce in the act of the convention-parliament, which, postponing her place in the succession, gave the throne to William in case he should survive Mary. But the sisters soon quarrelled, and never were reconciled. The misunderstanding began in trifling questions of etiquette, quite fitted to the calibre of both of the royal minds; but considerations of real importance soon compelled the king himself to interfere. The Churchills, traitorous to their new sovereign, as they had been to the old, were known to be intriguing for the restoration of James; and they induced Anne to write secretly to her father, and declare repentance for her desertion of him. Even when William dismissed Marlborough from all his places, the princess obstinately persisted in retaining his wife in her household. After Queen Mary's death, the king and his sister-in-law went through the forms of a reconciliation: but there was no confidence on either side; and indeed the secret correspondence with Saint Germains was still carried on. The state of the succession to the crown threatened new difficulties. Anne had seventeen children, but most of them were still-born: and the Duke of Gloucester, the only one who survived infancy, died in 1700 at the age of eleven. The Jacobites, however, were unable to prevent the passing of the act of settlement, which placed the Electress of Hanover after Anne in the succession to the crown.

On the 8th of March 1702, Anne became Queen of England by the death of William, being then 38 years of age. Into her short reign there were crowded events possessing vast importance, both for the British Empire and for the whole of Europe: and her name is customarily associated with one of the most characteristic epochs in the history of English literature. Marlborough and Peterborough commanded her armies: her councils were directed in succession by Godolphin and Somers, by Harley and St John: Berkeley and Newton speculated and experimented: and the "wits of Queen Anne's time" were mustered, in poetry and in prose, under such chiefs as Prior and Pope, Swift, Addison, and Steele, Arbuthnot and Defoe. But no sovereign could have exerted less of real and personal influence than Queen Anne did, either on the national polity or on the national enlightenment. A blessed thing was it that she should have been thus powerless. For, beyond her own epicurean comforts, and the petty ceremonial of her court, there were just three ideas which her narrow and uninstructed intellect admitted: each of these ideas was full of danger to the peace and happiness of the state; and each of them was cherished by her with the hereditary stubbornness of a Stuart. She was as eager as any one of her race to enlarge the prerogatives of the crown: her father's devotion to the Church of Rome was not stronger than was her desire to increase the power of the Church of England; and she never ceased to wish earnestly that her exiled brother should be her successor on the throne. In no stage of Anne's reign was even the last of these designs impracticable: there were always able statesmen inclined to lead the way; and more than once the tide of public opinion set towards absolutism, both political and ecclesiastical. The queen, however, was not only dull and ignorant, but also indolent, fond of flattery, and accustomed from her youth to let herself be guided by stronger and more active minds than her own. Whatever her wishes might be, her actions were ruled by her female favourites. Fortunately the earlier of her two directresses, a woman of extraordinary force of

Anne. character, was both willing and able to keep in check the queen's private inclinations: not less fortunate was it that the sway exercised by the next possessor of the royal favour was speedily cut short by her mistress's death. The course of English history might have flowed less smoothly, if the Duchess of Marlborough and her husband had not become convinced that their own interest lay in supporting the principles of the Revolution; and those principles might have sustained a rude shock, if Mrs Masham and her Jacobite allies had been allowed a few months longer to mature the queen's plans and their own.

The reign of Queen Anne, lasting for twelve years, falls naturally into two unequal periods.

During the first of these, the Duke of Marlborough was paramount in the houses of parliament, and his wife in the royal closet. A ministry of Tories was formed on the queen's accession; but the leaders of it were Marlborough and Godolphin, who immediately began to edge off from their party. The principal measures were, from the beginning, in substantial conformity to the policy of King William: the war with France, hardly resisted then by any part of the nation, was prosecuted with ardour and success; and the victories of Oudenarde, Ramillies, and Blenheim, gained by the consummate generalship of Marlborough, made England formidable and illustrious throughout Europe. In the internal affairs of the kingdom, Whig principles for a time prevailed more and more; the party acquired a decided majority in the House of Commons; and the ministry came to be composed almost entirely of Whigs, some of the Tories being dismissed, and others, like the two leaders, showing the accommodating flexibility of opinion which was so rife among the statesmen of that slippery age. The Union of England and Scotland was carried through in the face of many difficulties; and, while the proceedings of the ministry in the matter were by no means perfectly pure, the measure owed its success mainly to the independent and honourable assistance of the best man among the Whigs, the accomplished and patriotic Lord Somers. During several years, in short, barriers were gradually and firmly built up against the old system, and the old parties. But other days were at hand. The domineering favourite of the queen presumed rashly on her power, and offended the self-esteem of her mistress. Mrs Masham, a poor relation of the duchess, whom she had introduced into the royal household, soothed Anne's fretful temper, gratified her vanity, and quickly, though secretly, acquired her confidence and affection; and, under the guidance of the new favourite, and her prompter Harley, the queen was encouraged to hope for the attainment of all her most cherished aims. The state of public opinion underwent a corresponding change. Even under the masterly government of William, disappointments had been felt by those who expected impossibilities from the Revolution: discontent now diffused itself very widely, the main cause being the increase of taxation which had been rendered necessary by the continental war. The Tories and Jacobites, led by some of the ablest of the statesmen, and assisted by some of the most skilful and energetic of the political writers, dexterously used the combustible materials that were accumulating, and made the Church also an active engine of mischief. The ministry saw their parliamentary majorities wasting away; they were personally treated at court with open contumely: and their ruin was completed when, still relying too boldly on their supposed strength, they impeached Sacheverell for publicly preaching in favour of Jacobitism and the divine right of kings. In August 1710 the Whig administration was ignominiously discarded.

The second period of the queen's reign began at this point. She was thenceforth governed by Mrs Masham; Mrs Masham was governed by Harley and St John, the chiefs of the new ministry; and these able and unscrupulous men exerted themselves to the utmost of their power in undoing all that had been done by their predecessors. The fruits of the war were immediately abandoned, and the allies of England shamefully betrayed, by the Treaty of Utrecht. If open attacks were not made on the constitution, it was only because the parliament could not be trusted in such a case; and because, also, the two ministerial leaders became jealous of each other, and formed separate intrigues. Harley, the Sinon of the time, corresponded both with St Germains and with Hanover; St John, more decidedly Jacobite, plotted with Mrs Masham and the queen to procure the crown for the Pretender, on the ostensible condition of his professing Protestantism. But these cabals oozed out sufficiently to alarm the honourable Tories, and to array them and the bishops against the ministry in parliament. The time, likewise, during which the danger was growing, proved too short to allow it to become ripe. Harley and Mrs Masham came to an open quarrel one evening in Anne's presence: after they had squabbled for hours, the poor queen just retained strength enough to insist that the minister should resign on the spot: she then retired, at two in the morning, and lay down on her deathbed. She was seized with apoplexy, and died on the 1st of August 1714. St John's schemes were not ready for execution; and, by the prompt activity of a few patriotic statesmen, the accession of George I. was immediately and peaceably secured. (W. S.)

Anne Boleyn ‖ St Anne's Day.

ANNE BOLEYN or BULLEN, queen of King Henry VIII., was the daughter of Sir Thomas Boleyn, a nobleman of a powerful family and numerous alliances. The daughter of the Duke of Norfolk was her mother, and during the reign of the former king her father had been honoured with several embassies. Mary, the king's sister, who married Louis XII., carried over this lady with her to France at an early age, where she imbibed the freedom, the vivacity, and the openness of manners of that nation. After the death of Louis, that queen returned to England, and Anne continued to attend her royal mistress. Having some time after left her service, she was introduced into the family of the Duchess of Alençon. On her return to England, famed for personal beauty and acquired accomplishments, the king, influenced as much by his passion for the youthful Anne as by regard to the canon law, began to express his scruples concerning his union with Catherine of Aragon. Anne was placed at court and distinguished by many marks of royal favour, and the enamoured monarch openly expressed his attachment to her; but she was possessed of too much virtue and policy to confer any improper favours. This prudent and virtuous restraint only increased the passion of the impetuous Henry; who at length came to the resolution of divorcing his queen, to make way for his favourite. Various delays and difficulties occurring to the divorce, Henry privately married Anne during the month of November 1532; and in April following he publicly declared her queen of England. The issue of this marriage was the wise and fortunate Queen Elizabeth, who was born in September following. For some time Anne enjoyed a considerable share of the royal favour, and she made use of that influence in subduing the haughty prelate Wolsey, and widening the breach between the king and the pope. But this favour was not of long continuance; for the king, ever varying in his temper, allowed jealousy to enter his bosom, which her thoughtless demeanour tended in some measure to excite. She was accused of adultery with several of the household officers, and even with her own brother Lord Rochford; and having been tried on a charge of high treason, was condemned on very inadequate evidence to be beheaded; which sentence was executed in May 1536. She resolutely denied to the last any serious guilt.

St Anne's Day, a festival of the Roman and Greek

Annealing. churches, celebrated by the Latins on the 26th of July, but by the Greeks on the 9th of December. It is kept in honour of Anne or Anna, mother of the Virgin Mary.

ANNEALING, by the workmen called *nealing*, is a process used in glass-making, and in the manufacture of certain metals. In glass-making it consists in placing the bottles, &c. whilst hot, in a kind of oven or furnace, where they are suffered to cool gradually. They would otherwise be too brittle for use. The difference between unannealed and annealed glass, with respect to brittleness, is very remarkable. When an unannealed glass vessel is broken, it often flies into a small powder, with a violence seemingly very unproportioned to the stroke it has received. In general it is in greater danger of breaking from a very slight stroke than from one of some considerable force. One of these vessels will often resist the effects of a pistol bullet dropt into it from the height of two or three feet; yet a grain of sand falling into it will make it burst into small fragments. This takes place sometimes immediately on dropping the sand into it; but often the vessel will stand for several minutes after, seemingly secure; and then, without any new injury, it will fly to pieces. If the vessel be very thin, it does not break in this manner, but seems to possess all the properties of annealed glass.

Glass.

The same phenomena are still more strikingly seen in glass drops or tears. They are globular at one end, and taper to a small tail at the other. They are the drops which fall from the melted mass of glass on the rods on which the bottles are made. They drop into the tubs of water which are used in the work; the greater part of them burst immediately in the water. When those that remain entire are examined, they discover all the properties of unannealed glass in the highest degree. They will bear a smart stroke on the thick end without breaking: but if the small tail be broken, they shiver into small powder with a loud explosion. They appear to burst with more violence, and the powder is smaller, in an exhausted receiver, than in the open air. When they are annealed they lose these properties.

Glass is one of those bodies which increase in bulk when passing from a fluid into a solid state. When it is allowed to crystallize regularly, the particles are so arranged that it has a fibrous texture. It is elastic, and susceptible of long-continued vibrations; but when a mass of melted glass is suddenly exposed to the cold, the surface crystallizes, and forms a solid shell round the interior fluid parts. This prevents them from expanding when they became solid. They therefore have not the opportunity of a regular crystallization, but are compressed together with little mutual cohesion. On the contrary, they press outward to occupy more space, but are prevented by the external crust. In consequence of the effort of expansion in the internal parts, the greater number of glass drops burst in cooling; and those which remain entire are not regularly crystallized. A smart stroke upon them communicates a vibration to the whole mass, which is nearly synchronous in every part; and therefore the effort of expansion has little more effect than if the body were at rest; but the small tail and the surface only are regularly crystallized. If the tail be broken, this communicates a vibration along the crystallized surface without reaching the internal parts. By this they are allowed some expansion; and overcoming the cohesion of the thin outer shell, they burst it, and are dispersed in powder.

In an unannealed glass vessel the same thing takes place. Sometimes the vibration may continue for a considerable time before the internal parts overcome the resistance. If the vessel be very thin, the regular crystallization extends through the whole thickness; or at least the quantity of compressed matter in the middle is so inconsiderable as to be incapable of bursting the external plate.

By the process of annealing the glass is kept for some time in a state approaching to fluidity; the heat increases the bulk of the crystallized part, and renders it so soft, that the internal parts have the opportunity of expanding and forming a regular crystallization. Annealing.

Iron.

In the manufactures in which the malleable metals are employed, annealing is used to soften a metal after it has been rendered hard by the hammer; and also to soften cast-iron, which is rendered very hard and brittle by rapid cooling.

In the manufacture of steel goods, which are first formed by the hammer, and require to be filed or otherwise treated, and in which softness and flexibility are essential to the change, annealing is absolutely necessary. This is particularly the case in making files and scissors, that the metal may be left sufficiently soft for cutting the teeth, and for filing off those parts which cannot be ground. Annealing is not less necessary in the drawing of wire, whether iron, copper, brass, silver, or gold. The operation of drawing soon gives the wire a degree of hardness and elasticity which, if not removed from time to time by annealing, would prevent the extension of the wire, and render it extremely brittle. The same operation is also necessary in rolling or flattening those metals which are in a cold state, such as brass, silver, gold, &c. The brazier who forms vessels of copper and brass by the hammer, can work upon it only for a little time before he is obliged to anneal it.

The methods often employed for annealing iron and steel are very injudicious, and materially injure the latter when it is used for making cutting instruments. After they have been formed by the hammer, they are sometimes piled up in an *open* fire, slowly raised to red heat, and then allowed as gradually to cool. By this method the surface of the steel will be found considerably scaled, from the action of the oxygen of the atmosphere. When it is remembered that steel consists of iron joined to carbon, it will be evident that the steel immediately under the scaly oxide will be deprived of its carbon, which has been carried off by the attraction of the oxygen; and, in consequence, will lose the property of acquiring that degree of hardness necessary to a cutting instrument.

Nothing, therefore, can be more obvious, than that steel particularly should be annealed in close vessels, to prevent that effect. For this purpose the goods should be placed in a trough or recess made of fire-stone or fire-brick, and stratified with ashes or clean sand, and finally covered with a thick stratum of the same; but if the size of the vessel be small, it may have a cover of its own materials. This oven or trough must now be heated by the flame of a furnace passing under and round it, till the whole is of a red heat. It must then be suffered to cool, without letting in the air. The goods so treated will be much softer than by the other method. The surface, instead of becoming scaled, will have acquired a metallic whiteness, from the presence of a small quantity of carbonaceous matter contained in the ashes in which they were imbedded. They will become so flexible also, as to allow them to bend considerably without breaking, which is very far from being the case before the operation. The fracture, before annealing, will be smooth and short; but afterwards it will be rough, exhibiting bright parts, of a crystalline appearance. Wire, especially that of iron and steel, should be treated in a similar way when it is annealed. The wire used for some purposes requires to be soft, and is sold in that state. If the wire, after finishing, when it is bright and clean, were to be annealed in contact with oxygen, it would not only lose all its lustre and smoothness, but much of its tenacity. The process above mentioned will therefore be particularly necessary in annealing finished wire, as well as in softening it from time to time during the drawing.

Copper and brass suffer much less than iron and steel from annealing in the open air, and do not require to be heated above a low red heat. If, however, the lustre is to be preserved, a close vessel would be desirable. The latter metals, after annealing, although much discoloured by the oxygen of the atmosphere, may be cleansed by immersion in a hot liquor composed of water and a small quantity of sulphuric or nitric acid. Very small brass or copper wire is frequently annealed by exposing it to the flame of hay or straw. In casting minute pieces of pig-iron, which is generally done in damp sand, the metal possesses the property of steel to such a degree as to assume, by the rapid cooling, a degree of hardness equal to hardened steel; at the same time that the articles are so brittle as to break by falling on the ground. When, however, these goods are treated in the way above directed, they acquire a degree of softness which renders them penetrable by the file, and at the same time capable of bending. In this state they are much less tenacious than steel, but still so much so as to have been sold in the form of cutlery for steel.

The change which metals undergo by annealing is not yet thoroughly understood. Most of the malleable metals are susceptible of two distinct forms, one called the crystalline form, which they assume by slow cooling; and the other the fibrous, which is acquired by hammering or rolling. When this, however, is carried beyond a certain point, the metal becomes so hard that it is not capable of being bent far without breaking. All the malleable metals in the ingot or in their cast state are brittle, and exhibit a crystalline fracture. By hammering or rolling they become more tenacious, and break with difficulty, exhibiting what is called a fibrous fracture. At the same time they become stiffer and more elastic. They lose the latter properties by annealing, but become more malleable. If the annealing, however, be long continued, the malleability diminishes, and they again have a crystalline fracture. Zinc by wire-drawing becomes very flexible, and possesses a degree of tenacity not inferior to that of copper; but, if it be kept in boiling water for a length of time, it will resume its original brittleness, and show a crystalline appearance when broken. This proves that the particles of metals can change their arrangement without losing their solid form; which is still more strongly confirmed by the fact, that brass wire loses its tenacity by exposure to the fumes of acids, and even by the presence of a damp atmosphere. This is not caused by the moisture, but by the action of air upon the moistened surface. The manufacturers of common pins are obliged to keep their wire in a dry atmosphere, or immersed in water. If the wire be first moistened, and then exposed to the air, it will assume the brittle state much sooner. In this condition it breaks with a crystalline fracture, similar to that exhibited by an ingot. When a steel plate, such as a watch-spring, has been once tempered, the operation of simply rubbing it bright will render it soft and elastic. The same change is brought about by slightly hammering it. It, however, resumes its elastic state by being carefully heated till it becomes of a blue colour. If the heat be continued to redness, particularly in a close vessel, it becomes perfectly annealed. (C. S—R.)

ANNECY, a city in the kingdom of Sardinia, the capital of the province of Genevois, in the duchy of Savoy. It is at the foot of the mountain Semina, on the banks of the lake of that name. It is the most industrious place in Savoy, having manufactures of cotton goods, of hats, glass, and earthenware, besides several distilleries and tanneries; and near it are some iron-works. It contains a cathedral, a church, five monasteries, and the same number of nunneries. The relics of St Francis de Sales, preserved in St Mary's Church, draw many prilgrims annually to the city. Pop. 9000. Long. 6. 9. E. Lat. 45. 53. N. The lake of Annecy is about nine miles in length by two in breadth, and its surface is 1400 feet above the sea. It lies 20 miles south of Geneva, in the midst of exquisite mountain scenery.

ANNELIDES, or ANNELIDA, worms with red blood, are the first class of the third grand division of animals, the *Articulata*. See HELMINTHOLOGY.

ANNESLEY, ARTHUR, Earl of Anglesea, and lord privy seal in the reign of King Charles II., was the son of Sir Francis Annesley, baronet, Lord Mount-Norris, and Viscount Valentia, in Ireland, and was born at Dublin on the 10th of July 1614. He was for some time at the university of Oxford, and afterwards studied the law at Lincoln's Inn. He had a considerable share in public transactions, for in the beginning of the civil war he sat in the parliament held at Oxford; but afterwards became reconciled to the opposite party, and was sent commissioner to Ulster, to oppose the designs of the rebel Owen Roe O'Neal. He engaged in several other affairs with great success. He was president of the council of state after the death of Cromwell, and was principally concerned in bringing about the Restoration; soon after which King Charles II. raised him to the dignity of a baron, by the title of Lord Annesley of Newport-Pagnel, Bucks; and a short time after he was made Earl of Anglesea. During that reign he was employed in some important affairs, was made treasurer of the navy, and for some time held the office of lord privy seal. He was a person of great abilities, of very extensive learning, and was well acquainted with the constitution and laws of England. He died in April 1686, in the 73d year of his age. In his lifetime he published the following pieces:—

1. Truth unveiled, in behalf of the Church of England; being a Vindication of Mr John Standish's Sermon, preached before the King, and published by his Majesty's command. 1676, 4to. To which is added, A short Treatise on the subject of Transubstantiation. 2. A Letter from a Person of Honour in the Country, written to the Earl of Castlehaven; being observations and reflections on his Lordship's Memoirs concerning the Wars of Ireland. 1681, 8vo. 3. A true Account of the whole Proceedings between James Duke of Ormond and Arthur Earl of Anglesea, before the King and his Council, &c. 1682, folio. 4. A Letter of Remarks upon Jovian. 1683, 4to. Besides these, he wrote several other works, some of which were published after his decease; as, 5. The Privileges of the House of Lords and Commons, argued and stated in two conferences between both Houses, April 19 and 22, 1671: To which is added, A Discourse, wherein the rights of the House of Lords are truly asserted; with remarks on the seeming arguments and pretended precedents offered at that time against their Lordships. 6. The King's Right of Indulgence in Spiritual Matters, with the Equity thereof asserted. 1688, 4to. 7. Memoirs, intermixt with moral, political, and historical observations, by way of discourse, in a Letter to Sir Peter Pett. 1693, 8vo.

ANNEXATION, the act of annexing or uniting one thing to another. In law it is applied to the uniting of lands or rents to the Crown. In *Scottish Law* it also signifies the appropriation of church-lands to the Crown, and of lands lying at a distance from the kirk to which they belong to another kirk to which they are more contiguous.

ANNIVERSARY, the annual return of any remarkable day. Anniversary days, in old times, more particularly denoted those days in which an office was yearly performed for the souls of the deceased, or on which the martyrdom of the saints was yearly celebrated in the church.

ANNOBOM, or ANNABONA, a small island of Africa, on the west coast of Loango. It lies in Long. 5. 35. 7. E. and Lat. 1. 24. 3 .S., 190 miles west of Cape Lopez, is about four miles in length, and two in breadth, and rises abruptly from an unfathomable depth to the height of 3000 feet above the level of the sea. It is a beautiful island, exhibiting a succession of little valleys, with fine outlines of steep mountains richly clothed with wood, while every ledge and crevice

gives nourishment to a rich luxuriance of vegetation, and the precipitous surfaces are tinged with every variety of colour. Vessels touch at Annobom for refreshments, of which the supply is abundant, including swine, sheep, goats, fowls, bananas, plantains, cassada, sweet potatoes, pines, and tamarinds. Guinea-fowl, large and finely flavoured, are particularly plentiful. Cassada, cotton, and sugar-cane are cultivated with care and success. The population amounts to about 3000, mostly collected in a large village near the north-east point of the island, off which is the only tolerably safe roadstead for shipping. The people are negroes, perfectly harmless, and with some vague idolatrous belief in the Roman Catholic religion. In their dealings with strangers they are not strictly honest, but as much so as can reasonably be expected. Their houses are small and rudely constructed. Supplies are procured from them more readily by barter than for money. Cheap tawdry kerchiefs, old clothes, muskets, fish-hooks, cutlery, trinkets, rum, and tobacco, are the objects chiefly coveted. Their government was a sort of oligarchy vested in five persons, who assumed office by turns, strangely enough measuring its tenure by the arrival of ships, each magistracy lasting during the period of the arrival of ten. The island received its name from its having been discovered by the Portuguese on New-year's day, A.D. 1473. In 1778 it came into the possession of Spain; and in 1827 it was taken possession of by the English, but was restored to Spain in 1843.

ANNONÆ PRÆFECTUS, an extraordinary magistrate at *Rome*, whose business it was to prevent a scarcity of provisions. and to regulate the price, weight, and fineness of bread.

ANNONAY, a town of France, in the department of Ardeche, situated at the confluence of the rivers Cance and Deaume, 37 miles south of Lyons. It is a very prosperous manufacturing town, irregularly built, and presents little worthy of notice, except an obelisk in honour of the celebrated Montgolfier (who was a native of this place), and a suspension bridge in its vicinity, the first constructed in France. The principal manufacture is that of paper, long reckoned the best in France. It has also manufactures of gloves, cotton, woollen, and silk. Pop. 9893.

ANNUALRENT, in *Scottish Law*, denotes the yearly interest or profit due by a debtor in a sum of money to a creditor for the use of it.—A *Right of* ANNUALRENT was the original method in Scotland of burdening lands with a yearly payment for the loan of money, before the taking of interest was allowed.

ANNUITIES.[1]

THE doctrine of Compound Interest and Annuities-certain is too simple ever to have occupied much of the attention of mathematicians: inquiries into the values of interests dependent upon the continuance or the failure of human life, being more interesting and difficult, have occupied them more, but yet not so much as their importance would seem to demand; the discoveries both in Pure Mathematics and Physics, especially those of Newton, which distinguished the close of the seventeenth century, having provided them with ample employment of a more interesting kind, ever since the subjects of this article were submitted to calculation.

Fermat, Pascal, and Huygens, by laying the foundation of the doctrine of probabilities, about the middle of that century, first opened the way to the solution of problems of this kind. The earliest mathematical publication on probabilities, the little tract of Huygens, *De Ratiociniis in Ludo Aleæ*, appeared in 1658; and in 1671 his celebrated countryman John de Witt published a treatise on Life-Annuities in Dutch. (Montucla, *Hist. des Math.* tome iii. p. 407.) This, however, appears to have been very little known or read, and to have had no sensible influence on the subsequent progress of the science, the origin of which may be properly dated from the publication of Dr Halley's paper on the subject, in the *Philosophical Transactions* for the year 1693 (No. 196). That celebrated mathematician there first gave a table of mortality, which he had constructed from observations made at Breslaw, and showed how the probabilities of life and death, and the values of annuities and assurances on lives, might be determined by such tables; which, he informs us, had till then been only done by an imaginary valuation. Besides his algebraical reasonings, he illustrated the subject by the properties of parallelograms and parallelopipedons: there are, perhaps, no other mathematical inquiries, in the prosecution of which algebra is entitled to so decided a preference to the elementary geometry as in these, and this example of the application of geometry has not been followed by any of the succeeding writers.

In the year 1724 M. de Moivre published the first edition of his tract entitled *Annuities on Lives*. In order to shorten the calculation of the values of such annuities, he assumed the annual decrements of life to be equal; that is, that out of a given number of persons living at any age, an equal number die every year until they are all extinct; and upon that hypothesis he gave a general theorem, by which the values of annuities on single lives might be easily determined. This approximation, when the utmost limit of life was supposed to be 86 years, agreed very well with the true values between 30 and 70 years of age, as deduced from Dr Halley's table; and the method was of great use at the time, as no tables of the true values of

[1] Hardly any terms are made use of in this article which may properly be considered technical. But since it is desirable that the reader should have perfectly clear and well-defined ideas of the terms that are employed, in the demonstrative part, which follows the historical, a few have been defined in the paragraphs where they are first introduced; and we here give those terms in alphabetical order, with the numbers of the paragraphs in which their definitions are given:—

Term.	*Paragraph.*
Annuity	3
Annuity, Certain	4
Annuity, Deferred	20
Annuity, Life	31
Annuity, Temporary Life	58
Annuity on any Life or Lives	62
Assurance on any Life or Lives	77
Mortality, Table of	32
Years' Purchase, No. of, that an Annuity is worth	6

History. annuities had then been calculated, except a very contracted one inserted by Dr Halley in the paper mentioned above. But, upon the whole, this hypothesis of De Moivre has probably contributed to retard the progress of the science, by turning the attention of mathematicians from the investigation of the true law of mortality, and the best methods of constructing tables of the real values of annuities.

The same distinguished analyst also endeavoured to approximate the values of joint lives; but it has since been found that the formulæ he gave for that purpose are too incorrect for use. Mr Thomas Simpson published his *Doctrine of Annuities and Reversions* in the year 1742, in which the subject is treated in a manner much more general and perspicuous than it had been previously. His formulæ are adapted to any table of mortality; and, in the seventh corollary to his first problem, he gave the theorem demonstrated in the 149th number of this article, to which we owe all the best tables of the values of life-annuities that have since been published.

In the same work he also gave a table of mortality deduced from the London observations, and four others calculated from it, of the values of annuities on lives, each at three rates of interest; the first for single lives, the three others for two and three equal joint lives, and for the longest of two or of three lives.

These were the first tables of the values of joint lives that had been calculated; for although Dr Halley had shown, half a century before, how such tables might be computed, and had taken considerable pains to facilitate the work, the necessary calculations by the methods known previous to the publication of Mr Simpson's treatise were so very laborious that no one had had the courage to undertake them. And unfortunately the mortality according to the London table was so much above the common average, that the values of annuities in Mr Simpson's tables were much too small for general use.

In the year 1746 M. Deparcieux published his *Essai sur les Probabilités de la Durée de la Vie Humaine*, in which he gave several valuable tables of mortality deduced from the mortuary registers of different religious houses, and from the lists of the nominees in the French tontines; also a table of the values of annuities on single lives, at three rates of interest, calculated from his table of mortality for the tontine annuitants. These tables were a great acquisition to the science, as, before their publication, there were only two extant that gave tolerably exact representations of the true law of mortality—Dr Halley's for Breslaw, and one constructed but a short time before by M. Kersseboom, principally from registers of Dutch annuitants. Those of M. Deparcieux for the monks and nuns were the first ever constructed for the two sexes separately; and by them the greater longevity of females was made evident.

The work commences with an algebraical theory of annuities-certain; but the principal essay, *On the Probabilities of the Duration of Human Life*, is perfectly intelligible to those who have not studied mathematics. It is written with great judgment and perspicuity, but contains very little more than the explanation of the construction of his tables, some of which relate to tontines; and he did not avail himself to the extent he might have done, of the excellent tract of Thomas Simpson.

This work, however, appears to have been more read upon the Continent, and to have contributed more to the diffusion of this kind of information there, than all the other writings on the subject. The article *Rentes Viagères* in the French *Encyclopédie* is acknowledged to have been taken entirely from it, as was also the article Vie, *durée de la;* and these are proofs, among many others that might be produced, how little M. d'Alembert and the principal mathematicians his contemporaries attended to the subject.

In the year 1752 Mr Simpson published, in his *Select Exercises*, a supplement to his doctrine of Annuities; wherein he gave new tables of the values of annuities on two joint lives, and on the survivor of two lives, much more copious than those he had inserted in the principal work; but these also were calculated from his London table of mortality.

The celebrated Euler, in a paper inserted in the *Memoirs of the Royal Academy of Sciences at Berlin* for the year 1760, gave a formula by which the value of an annuity on a single life of any age may be derived from that of an annuity on a life one year older; which formula was included in that given by Mr Simpson 18 years before for effecting the same purpose in the case of any number of joint lives; and by this compendious method M. Euler calculated a table of the values of single lives from M. Kersseboom's table of mortality.

The first edition of Dr Price's *Observations on Reversionary Payments* was published in 1770, and its chief object was, to give information to persons desirous of forming themselves into societies for the purpose of making provision for themselves in old age, or for their widows. When tables of the values of single lives, and of two joint lives, are given, the methods of determining the terms on which such provisions can be made with safety to all the parties concerned are very simple, and were at that time well understood in theory by the mathematicians who had studied the subject; but, for want of the requisite tables, the algebraical formulæ had till then been of little practical utility.

In the prosecution of this laudable design, Dr Price was obliged to have recourse to approximations. He informs us, that by following M. de Moivre too implicitly in his rules for determining the value of two joint lives, he was led into difficulties which convinced him that they were not only useless but dangerous: he therefore calculated a table of these values upon M. de Moivre's hypothesis of the decrements of life being equal, and its utmost limit 86 years, from a correct formula given by Mr Simpson in his doctrine of Annuities (Cor. 5, Prob. 1). By this, and a table of the values of single lives, calculated by Mr Dodson on M. de Moivre's hypothesis, he was enabled to give answers tolerably near the truth, to some of the most interesting questions of this kind, and to show that the plans of several of the societies then recently established, were quite inadequate; and instead of the benefits they promised, could only, in the end, produce disappointment and distress, unless they either dissolved or reformed themselves.

The work also contained instructive dissertations on the probabilities and expectations of life, and on the mean duration of marriage and of widowhood; besides accounts of some of the principal societies which had then been formed for the benefit of old age and of widows, with observations on the method of forming tables of mortality for towns, and two new tables of that kind constructed from registers kept at Norwich and Northampton. Mr Morgan's *Doctrine of Annuities and Assurances* was published in 1779, containing tables of the values of single lives, of two equal joint lives, and of two lives differing in age by 60 years, calculated from the Northampton table of mortality. And in the same year M. de Saint-Cyran published his *Calcul des Rentes Viagères sur Une et sur Plusieurs Têtes*, wherein the valuation of annuities on lives is treated algebraically, but in a manner much inferior in all respects to that of Mr Simpson; and six tables are given of the values of annuities—on single lives, on the survivor of two lives, and on the last survivor of three, calculated

from M. Kersseboom's table of mortality. Although the values in the cases of two and of three lives were only determined by approximation, these tables were, just then, a valuable acquisition to the science; but their use was entirely superseded only four years after, by the publication of others much more valuable.

The fourth edition of Dr Price's *Observations on Reversionary Payments* appeared in 1783. One of the best effects of the preceding editions on the progress of the science had been, to direct the public attention to these inquiries, by showing their important uses in the affairs of life; and to procure the requisite *data* for forming tables of mortality, that should illustrate the laws according to which human life wastes under different circumstances, by exciting the curiosity of intelligent men who had the necessary leisure and means of information. The ingenious author had accordingly been furnished with the necessary abstracts of mortuary registers which had been kept with these views, by Dr Haygarth at Chester, Dr Aikin at Warrington, and the Rev. Mr Gorsuch at Holy-Cross, near Shrewsbury, since the publication of the first edition; also by Mr Wargentin, with the mean numbers both of the living and the annual deaths in all Sweden and Finland for 21 successive years; in all of which the sexes were distinguished; and from these *data* he constructed tables of mortality that threw great light on the subject. He also inserted in this edition an improved table of mortality for Northampton; and, what had been so long wanted, a complete set of tables of the values of annuities on single lives at six rates of interest, and on two joint lives at four, all calculated from the new Northampton table. The combinations of joint lives were sufficiently numerous to admit of all the values not included being easily interpolated. Besides these, he also gave tables of the values of annuities on single lives from the Swedish observations, both with and without distinction of the sexes, and on two joint lives without that distinction.

The values given in these tables are too low for the general average of lives at all ages under 60; but in the treatise of Mr Baron Maseres on the *Principles of the Doctrine of Life Annuities*, which was published in the same year (1783), others were given, calculated from the table of mortality which M. Deparcieux constructed from the lists of the nominees in the French tontines. The tables for single lives are calculated at twelve different rates of interest from 2 to 10 *per cent.*, but those for joint lives only at $3\frac{1}{2}$ and $4\frac{1}{2}$ *per cent.*; and the combinations they include are only those of ages that are equal, or that differ by 5 or 10 years, and the multiples of 10.

There is reason to believe that the values in these tables, at all ages under 75 or 80 years, are nearer the truth, for the average of this country, than any others then extant; but certainly for the average of lives on which annuities and reversions depend. After that period of life, however, they are too small; and, in most cases, it is difficult to derive the values of joint lives from them with sufficient accuracy, on account of the contracted scale they have been calculated upon.

It was not Dr Price's object to deliver the elements of the science systematically; but he treated most parts of it with great judgment, enriched it with a vast collection of valuable facts and observations, and corrected several errors into which some of the most eminent writers upon it had fallen. The mathematical demonstrations (which are given in the notes) are much inferior to the rest of the work.

The values of reversionary sums and annuities, which depend upon some of the lives involved failing according to assigned orders of precedency, had been approximated by Mr Simpson in his *Select Exercises*, and by Mr Morgan in his *Doctrine of Annuities*; but the latter gentleman first gave accurate solutions of problems of this kind, in the *Philosophical Transactions* for the years 1788, 1789, 1791, 1794, and 1799.

Mr Baily's *Doctrine of Life Annuities and Assurances* was published in 1810. In it the whole subject is treated, except the construction of tables of mortality, on which the practical application of all the rest depends. In consequence of the author having adopted Mr Simpson's notation, this work presented a more perspicuous exposition of the whole theory, especially of the improvements made in it between the time when Mr Simpson wrote and the date of its publication, than had previously appeared. And in an appendix to it, published in 1813, principally for the purpose of explaining the construction and uses of tables for determining the values of life-annuities, calculated at a vast sacrifice of time and labour by Mr George Barrett, since deceased, formulæ were given for calculating from tables of that kind the values of temporary and deferred life-annuities and assurances, and also for determining the values of annuities and assurances when the annuity or the sum assured, instead of remaining always the same, increases or decreases from year to year by equal differences, with considerably greater facility and expedition than the same things could have been effected with by the tables and methods of calculation in previous use.

Except by these improvements, and the solution of the problems above stated to have been first given by Mr Morgan, which were severely criticised and given anew, with some amendments besides the important one of the notation in Mr Baily's work, the science had not been materially advanced, during a period of more than 30 years, which had elapsed since the appearance of the fourth edition of Dr Price's observations, when Mr Milne published his *Treatise on the Valuation of Annuities and Assurances on Lives and Survivorships*, in the year 1815.

The work consists of two volumes; the first is mathematical, the second entirely popular, except the notes and a few of the tables. The algebraical part of this article is merely a short abstract of the first volume, and may serve as a specimen of the manner in which the subject has been treated there; but the construction of tables of mortality, which forms the subject of the third chapter, has not been noticed here; neither is the valuation of reversionary sums or annuities depending upon assigned orders of survivorship treated in the present article; and these are parts of the work which will not be found the least interesting to mathematicians.

The second volume contains upwards of 50 new tables, with a few others that had been published before, but have been reprinted either on account of their value or scarcity, or both. Four of the new ones are tables of mortality constructed by the author, from registers kept at Carlisle and Montpellier, and in all Sweden and Finland, since the period of the observations Dr Price made use of: the sexes are distinguished in the tables for Sweden and Montpellier, but not in that for Carlisle. This last is the only table, besides those for Sweden and Finland, applicable to the mass of the people, that has been formed from the necessary *data*,—enumerations of the living, as well as registers of the deaths, in every interval of age.

Twenty-one of these tables, being the seventeenth to the thirty-seventh inclusive, in the collection at the end of the work, render it easy to apply the algebraical formulæ to practical purposes, and numerous examples of such applications are given. They have all been calculated from the Carlisle table of mortality; those of the values of life-annuities on the same extensive scale with those

which Dr Price derived from the Northampton table. It is the author's opinion that the values of interests dependent upon the continuance or the failure of life may be derived from them more correctly than from any others then extant, and he has taken considerable pains to assist his readers in judging of this for themselves.

Besides the tables, the principal contents of the second volume are explanations of their construction and uses. Many of them relate to the progress of population,—the comparative mortality of different diseases, of different seasons,—and of the two sexes at every age, the proportion of the sexes at birth, and that of the born alive to the still-born of each sex.

It will be found that the author has collected records of facts and observations of great value, and that he has endeavoured to present the information they afford in the forms best calculated for the further prosecution of these inquiries.

Mr Gompertz's *Sketch of an Analysis and Notation applicable to the estimation of the value of Life Contingencies* was read at a meeting of the Royal Society on the 29th of June 1820, and printed in the Society's Transactions for that year.

The second edition of Mr Morgan's *Principles and Doctrine of Assurances and Annuities on Lives* was published in 1821. The formulæ for determining the values of contingent reversions, first given by the author in the *Philosophical Transactions*, as above stated, were in this second edition substituted for the approximations given in the first; and it contains tables of the values of annuities on single and joint lives, calculated from the Northampton and Sweden tables of mortality, and taken from Dr Price's *Observations on Reversionary Payments*.

This edition contains nothing new, except a table on the two last pages, showing the number of persons whose lives were insured in the Equitable Society, who died of each disease in each decade of age from 10 years to 80, and above 80 years of age, during a term of 20 years commencing with 1801. Also (in the last line of the table) " the number assured during the same term" in each of these intervals of age. The obvious meaning of this expression would seem to be, *the number of persons on whose lives assurances were effected by the Society during these* 20 *years, in each interval of age*. This is the sense in which Mr Babbage understood it, and therefore drew wrong inferences from it (in his *Comparative View of Life Insurance Institutions*, p. 63 and table 13). The late Dr Young was also misled by it, and appears to have taken those for the mean numbers of the lives on which the society had policies in force in the several intervals of age during these 20 years; and thence concluded that during these 20 years, according to that table, the mean number of lives of all ages on which the society had policies in force was more than 150,000, and that only one out of 1500 of them died annually. (*Philosophical Transactions*, 1826, p. 287.)

Indeed Mr Morgan himself, on the page preceding his table, stated that it contained an account of all the deaths which had happened in the society during 20 years, " among a population exceeding 150,000 persons."

If the numbers only in that last line of the table had been given, without any explanation of them, it would, upon due consideration, have been conjectured that they could be no others than the sums of the numbers of lives insured by the society which were found to be in those intervals of age at one and the same period in each of those 20 years; that is, 20 times the mean numbers of them in the several intervals during the same term. But neither of Mr Morgan's explanations of them would admit of that construction.[1]

The present article was first published in the Supplement to this Encyclopædia in 1816.

In the article on the Law of Mortality in that Supplement, which appeared in 1822, it was shown that, according to Mr Morgan's statement, made at a general court of the Equitable Society in the year 1800, of the mortality which had taken place among the lives insured by that society as compared with the Northampton table, the mortality among those lives in each decade of age from 10 years to 50 was very nearly the same as in the Carlisle table of mortality; also that, above 50 years of age, the difference, upon the average, was not great. And early in 1826 were published *Tables of Life Contingencies*, by Mr Davies, and *A Comparative View of the various Institutions for the Assurance of Lives*, by Mr Babbage; in each of which works was given a table of the mortality which had prevailed among the lives insured in the Equitable Society at all ages above 10 years, constructed from that statement of Mr Morgan.

Mr Babbage gave also a table of the values of annuities on single lives of all ages above ten years, derived from his table of mortality above mentioned; and the indefatigable Mr Davies gave tables of the values of annuities on single and joint lives, calculated both from his table of mortality above mentioned and from the Northampton table, rather fuller and more complete than any that had previously been published, except that those derived from the law of mortality in the Equitable Society necessarily included no ages under 10 years. The values according to the Northampton table were given only at the rates of 3 and 4 per cent. interest; but Mr Davies, not content to take them on Dr Price's authority, has, like Mr Barrett, calculated them anew, and, as well as the other values of annuities, has carried them to four places of decimals. This author's comprehensive little book also contains many other tables of the values of annuities and assurances on lives and survivorships, with one of the values of policies of assurance, calculated from the Northampton table of mortality at 3 per cent. interest, which, as well as many another single table contained in it, must have cost him much time and labour; and those derived from the Northampton table of mortality must be very valuable to such of the assurance companies as take that table for their guide in transacting business.

Mr Babbage and Mr Davies also gave formulæ and tables similar to, or not materially different from, those of Mr Barrett above mentioned, for determining the values of temporary and deferred, as well as increasing or decreasing annuities and assurances on single lives; the tables of Mr Babbage being derived from his table of mortality in the Equitable Society, and from the Carlisle table; that of Mr Davies from the Northampton table of mortality alone.

Mr Morgan, in the statement on which those tables of Mr Babbage and Mr Davies were founded, contented himself with the use of two simple digits only, to express the proportion of the mortality in the Equitable Society to that in the Northampton table in each decade of age; and although that gentleman for twenty-five years after 1800, when that statement of the thirty years' previous observations was made, continued, in Notes on Dr Price's *Observations on Reversionary Payments*, and in his addresses to the general courts of the Equitable Society, to state that the proportions still remained the same, the

[1] See the note at the end of this Historical Introduction.

observations extending over a period of fifty-five years, he never gave any statement more full or distinct.

These were but scanty materials certainly to construct a table of mortality from; and yet the agreement between the tables formed from them, and the best of other existing tables of mortality, is very remarkable.

A committee of the House of Commons on friendly societies having been appointed in 1827, chiefly for the purpose of inquiring into the law of mortality, and the values of life-annuities and assurances in this country, the report of that committee, by bringing the subject prominently before the public, and exciting attention to well-established but much neglected results of inquiries into it, had the effect of correcting to a considerable extent opinions upon it, taken upon trust without due examination, and generally diffused. The establishment of many new assurance companies, and the increasing prevalence of life-assurance for 15 or 20 years before, by exciting discussion and examination of their rates, had also contributed to produce that effect. At length the members of the Equitable Assurance Society, as the period of the decennial investigation of their affairs in 1829 approached, expressed a desire to avail themselves of the information respecting the law of mortality in the society which the office books might afford, for estimating and dividing their profits; and in 1828 Mr Morgan published a pamphlet entitled *A View of the Rise and Progress of the Equitable Society*, in which (p. 42) he gave the following " table of the decrements of life in the society during the preceding 12 years."

TABLE (a).

1	2	3	4
Age.	Number.	Died.	Should have died.
20 to 30	4,720	29	68
30 to 40	15,951	106	243
40 to 50	27,072	201	506
50 to 60	23,307	339	545
60 to 70	14,705	426	502
70 to 80	5,056	289	290
80 to 95	701	99	94

In the same place, the author informs his readers that " in his former statement (without mentioning which of them) he was not aware of the great number of instances in which there were several policies on one and the same life." Also that " the present is, in fact, the only correct table of the decrements of life in the society."

In the same pamphlet the author has given a table to show the law of mortality among the lives insured in the Equitable Society, founded upon his last statement; also a table of the expectations of life, and one of the values of annuities on single lives at three *per cent. per annum* interest, both derived from that table of mortality, none of them including any age under 20 years.

The author of the present article, when preparing this historical sketch, not clearly understanding the import of the numbers in the second column of this table (a), nor the last line in the table of deaths by the different diseases, given at the end of Mr Morgan's work on annuities (2d edit. 1821)—having also some doubts about the statement made in 1800—wrote to Mr Morgan, and requested the desired information respecting them, when that gentleman forwarded him the following:

1. That the second column should have been headed, " Number of persons living at the beginning of each year during the last 12 years;" and the fourth, " the number which should have died, according to the Northampton table."
2. That as to the table at the end of his treatise on annuities, he knew the numbers of deaths by the different diseases to be correct; but " the numbers in the last line of that table were those of the *policies*, which he had since found greatly to exceed the numbers of the *members*."
3. Upon his statement of 1800 Mr Morgan made no observation.

From the first part of the information thus obtained, it appears that the number in the second column on any line in table (a), is twelve times the mean number of lives in the interval of age set against it, on which the Equitable Society had policies in force during these 12 years; so that, in a society similar in all other respects, in which the law of mortality was constantly the same, and the number of lives in each interval of age was always just 12 times as great as in the Equitable during these 12 years, the population and mortality would be as in columns 2 and 3 of the following table (b).

TABLE (b).

1	2	3	4	5	6
			Of whom would die annually according to		
			Our calculations from		Mr Morgan's calculations from
Between the Ages of	Number constantly living.	Of whom die annually.	Mr Morgan's Table of Mortality in Equitable Society.	The Northampton Table of Mortality.	
20 & 30	4,720	29	37	74	68
30 & 40	15,951	106	150	299	243
40 & 50	27,072	201	337	648	506
50 & 60	23,307	339	536	780	545
60 & 70	14,705	426	664	726	502
70 & 80	5,056	289	460	461	290
80 & 95	701	99	146	147	94
Totals	91,512	1489	2330	3135	2248

If our inferences in the 4th and 5th columns of this table from Mr Morgan's *data* in the 2d and 3d be correct,[1] neither Mr Morgan's in the 6th column, nor his table of mortality, nor consequently those of the expectations and values of lives above mentioned, can have been accurately derived from the same *data*.

But even with these *data* we have reason to believe that Mr Morgan is not well satisfied, and that that gentleman has since been able to form a table from much more unexceptionable documents, which shows the probabilities

[1] It may be proper to show here, how our numbers in columns 4 and 5 have been determined. For this purpose we give as an example the manner in which the 2d in col. 5 has been calculated.

Expectation of life at $\left\{\begin{matrix} 30 = 28{\cdot}27 \times 4385 \\ 40 = 23{\cdot}08 \times 3635 \end{matrix}\right\}$ number annually attaining that age $= \left\{\begin{matrix} 123{,}964 \\ 83{,}896 \end{matrix}\right\}$ number living above $\left\{\begin{matrix} 30 \\ 40 \end{matrix}\right.$

The differences are the numbers between 30 and 40; 750 dying annually, and 40,068 constantly living.

And 40,068 : 750 : : 15,951 : 299 See article on LAW OF MORTALITY.

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of life, especially in the latter periods, to be much nearer the probabilities of life among mankind in general than he had previously imagined.

It is satisfactory to find Mr Morgan at last coming into an opinion, of the truth of which, evidence had previously been adduced sufficient to convince almost all who attended to it; and, trusting that he will publish the results of his latest inquiries on the subject, we shall take no further notice here of the table of the values of annuities in his pamphlet above mentioned, which, otherwise, we could not with propriety have avoided.

Mr Morgan (*Pamph.* p. 42 and 43) asserts that a comparison of columns 3 and 6 of this table (b) affords a striking proof of the accuracy of the Northampton table; but, to judge of that, we consider it is not column 6, but 5, which should be compared with column 3.

In the *Transactions of the Cambridge Philosophical Society*, vol. iii. part 1, are two papers by Mr Lubbock; the first *On the Calculation of Annuities, and on some Questions in the Theory of Chances* (read May 26, 1828); the other *On the Comparison of various Tables of Annuities* (read March 30, 1829).

In the year 1808 government commenced granting life-annuities at prices calculated from the Northampton table of mortality, and continued so to grant them for 20 years, at a great loss to the nation, especially when the lives were young, as was well known at the time to those who understood the subject; and was mentioned more than once by the author of the present article, to a very able and well-informed member of the government, not long after they commenced granting them. But none were then granted on lives under 35 years of age; and the gentleman alluded to only observed, that the applicants for annuities were principally aged persons, and it was desirable that a safe and advantageous mode of employing their savings should be afforded them. After the year 1816 those annuities were granted to persons of all ages above 21 years.

Although the *data* necessary for determining the law of mortality among the people, and the values of pecuniary interests dependent upon the continuance or the failure of human life, cannot be obtained without the active concurrence of many persons of influence and authority; yet, for all the tables containing information of that kind relative to this country, and published before the year 1829, the public were indebted to the zeal and industry, and the separate efforts, of a few individuals.

But in March 1819 Mr Finlaison was appointed by government, with all the aids they could afford him, including proper assistants, and access to the registers of the nominees in tontines, and others on whose lives annuities had been granted by government for more than a hundred years before; in which registers the exact ages at which the annuitants were nominated, and those at which they died, were stated.

Thus the *data* not otherwise accessible being provided, and the labour lessened by the number of calculators employed—the expense also being defrayed by the public—at the end of ten years, viz. in March 1829, Mr Finlaison made a report to the Lords of the Treasury, which was printed by order of the House of Commons, and, in tables filling 50 folio pages, shows the rates of mortality, and the values of annuities on single lives at all ages, among many different classes of annuitants, both separate and combined; the sexes being generally distinguished both in exhibiting the law of mortality and the values of annuities.

These, from the number and accuracy of the *data*, are more valuable than any thing of the same kind that had previously been published; but it is the values of annuities only which we have to notice here.

The lives on which annuities depend will generally be somewhat better (by which we here mean, will attain to greater longevity) than the general average of the population, though probably not nearly so much better as many believe them to be. The prevailing error in the popular estimate on this subject appears to have arisen in great measure from comparing the mortality among annuitants and assured lives, with that represented to take place by tables of mortality erroneously considered to correspond with the general average of the people; while, from being constructed on erroneous principles, and from insufficient *data*, or else being derived from observations made where the mortality was and is much greater than in Britain, the mortality according to these tables was considerably greater than that which actually prevails among the bulk of the people here. Proofs of this will be found under the article LAW OF MORTALITY.

That the lives on which annuities and assurances depend cannot be so very select or so much better than the common average as has generally been supposed, might reasonably be expected on these grounds:—

1. As to annuitants.

The lives are not all chosen on account of their presumed goodness; for many persons who have no occasion to provide for others who may survive them, purchase annuities on their own lives, only that they may themselves enjoy the whole benefit of the purchase-money, both principal and interest, during their lives.

And the greatest recommendation of these lives seems to be, that they are generally prudent persons, of temperate and regular habits.

Many other persons, especially females, spendthrifts, and faithful servants, enjoy annuities bequeathed to them by their deceased relatives, masters, or mistresses, as the most eligible provision for their future comfort and security from want; and there seems little ground to suppose them to be better lives than the common average of the same age and sex.

2. In such cases as tontines, where most of the lives are selected for their presumed goodness, the best criterion probably is, hereditary longevity in the family of the nominee; but partiality for their own friends or kindred often has considerable influence in biassing the judgment of those who select them.

That they will generally be persons of good constitutions and regular habits when selected, is all that is likely to be obtained under these circumstances; and that is also the case with the average of the population in comfortable circumstances.

Whatever the constitutions and habits of annuitants may be, the annuities held by them during their own lives, by protecting them from many of the wants, cares, and anxieties which the bulk of the people are exposed to, no doubt contribute to their longevity. But where powerful motives to raise money by the sale of an annuity on a person's own life exist, it is extremely difficult to prevent him from parting with it, whatever precautions may have been taken with that view; and with it, he also loses that help to longevity.

3. Insured lives are also generally supposed to be much better than the average of the population, as it is incumbent upon the insurance offices to be cautious in selecting them.

But bad lives, by the failure of which persons interested in them would sustain loss, are most likely to be offered, and are continually offered, for insurance; and there is reason to believe that all the caution in selection which the offices in general can exercise, is necessary to keep the lives insured up to the average goodness of the bulk of the population;—supposing always that people in gene-

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ral of the industrious classes are in prosperous, or at least in comfortable circumstances. When that is not the case, as for some years previous to 1830 there is reason to apprehend it was not in this country, there will be a corresponding increase in the general mortality, which will not sensibly affect the general mass of persons on whose lives annuities and reversions or assurances depend.

In many cases of insurance, the managers who choose the lives know very little more about them than is stated by themselves or the medical attendants they refer to, and frequently they depend much on the reports of their agents in the country; but where they are in daily habits of intercourse with most of the persons whose lives they insure, or else in habits of intimacy with some who are so, they have the means of making a much better selection. That is stated to be the case with one of the London offices, and in which, accordingly, there is said to have been observed a remarkably small mortality.

For the reasons assigned above, it appears, that although lives carefully selected, with the advantage of the necessary facilities, and unmixed with others, may be considerably better than the general average, those on which annuities and assurances are granted are not, on the average, likely to be much better.

This part of the subject is also adverted to at the end of the article on the LAW of MORTALITY.

The two following Tables, A and B, show the number of Years' Purchase Annuities on Lives of different ages are worth in present money, according to MORE CORRECT Tables of Mortality.

TABLE A.

Without distinction of Sex.

RATE OF INTEREST FOUR PER CENT. PER ANNUM.

Column	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	
Description of Lives.	Nominees in the French Tontines.	Population of Carlisle and environs.	Equitable Assurance Society.	Nominees in English Tontines.				Population of Sweden and Finland.	First English Tontine.	
				Selected by Contributors.	Chosen by Lot.	The two last together.	Various combined.			
Observations began...	1690	1779	1770	1789	1789	1789	1773	1755	1693	
Ended..................	1742	1787	1800	1826	1826	1826	1826	1776	1783	
Years' duration	50	9	30	37	37	37	53	21	90	
Greatest number of lives...............	9260+	10,517+	6344+	3518	4831	8349	18,798	4,051,116	1002	
Mean number.........	5293±	8177	2522±	2860±	3920±	6780±	15,459±	2,310,160	501±	
Number of deaths.....	7933+	1840	1220±	1315	1823	3138	6,679	1,401,989	1002	
Table of Mortality published in......	1746.	1815.	1827.	1829.				1783.	1829.	
Constructed by........	Deparcieux.	Milne.	Davies.	Finlaison.				Price.	Finlaison.	
Age.										Age.
10	19·008	19·585	19·647	19·167	19·068	19·118	19·242	18·891	17·128	10
15	18·502	18·956	18·944	18·475	18·422	18·448	18·532	18·336	16·207	15
20	17·938	18·363	18·242	18·011	17·946	17·979	17·954	17·603	15·349	20
25	17·420	17·645	17·494	17·526	17·530	17·528	17·534	16·839	14·976	25
30	16·810	16·852	16·701	16·889	16·925	16·907	16·995	16·006	14·624	30
35	16·084	16·041	15·867	16·098	16·099	16·099	16·314	15·138	14·023	35
40	15·133	15·074	14·939	15·195	15·124	15·160	15·516	14·034	13·193	40
45	13·904	14·104	13·845	14·061	13·985	14·023	14·533	12·959	12·199	45
50	12·526	12·869	12·599	12·671	12·528	12·599	13·295	11·658	11·183	50
55	11·173	11·300	11·349	The numbers for the two classes separately were deemed insufficient at these ages.		11·163	11·915	10·320	10·141	55
60	9·713	9·663	10·052			9·772	10·491	8·789	8·836	60
65	8·039	8·307	8·635			8·308	8·896	7·328	7·342	65
70	6·394	6·709	7·167			6·729	7·316	5·783	5·823	70
75	4·945	5·239	5·670			5·122	5·837	4·534	4·456	75

TABLE B.

The Sexes distinguished.

RATE OF INTEREST FOUR PER CENT.							
	a	b	c	d	e	f	
	Sweden and Finland, 1755–1766. Dr Price.			British Tontines and Annuities, 1773–1826. Mr Finlaison.			
Age.	Male.	Female.	Excess in Value of a Female above a Male Life.		Male.	Female.	Age.
10	18·674	19·109	0·435	0·919	18·782	19·701	10
15	18·105	18·568	0·463	1·055	18·004	19·059	15
20	17·335	17·872	0·537	1·318	17·295	18·613	20
25	16·592	17·087	0·495	1·187	16·940	18·127	25
30	15·751	16·261	0·510	1·102	16·444	17·546	30
35	14·812	15·465	0·653	1·131	15·749	16·880	35
40	13·668	14·401	0·733	1·281	14·875	16·156	40
45	12·535	13·383	0·848	1·471	13·798	15·269	45
50	11·267	12·049	0·782	1·731	12·430	14·161	50
55	9·998	10·642	0·644	1·751	11·039	12·790	55
60	8·540	9·039	0·499	1·540	9·721	11·261	60
65	7·090	7·566	0·476	1·361	8·216	9·577	65
70	5·670	5·897	0·227	1·083	6·775	7·858	70
75	4·487	4·582	0·095	0·854	5·410	6·264	75

The three following Tables, M, N, and O, show the Values of Annuities on Lives, according to LESS CORRECT Tables of Mortality.—All without Distinction of Sex.

M.

RATE OF INTEREST FOUR PER CENT.					
	a	b	c	d	
Age.	London Bills, 1742. Simpson.	Demoivre's Hypothesis, 1753. Dodson.	Northampton Table, 1783. Price.	Mort. Regrs. in France, 1806. Duvillard.	Age.
10	16·4	16·882	17·523	17·882	10
15	15·8	16·410	16·791	17·154	15
20	14·8	15·891	16·033	16·442	20
25	14·0	15·318	15·438	15·747	25
30	13·1	14·684	14·781	15·021	30
35	12·3	13·979	14·039	14·214	35
40	11·5	13·196	13·197	13·286	40
45	10·8	12·322	12·283	12·218	45
50	10·1	11·344	11·264	11·026	50
55	9·3	10·248	10·201	9·709	55
60	8·4	9·017	9·039	8·342	60
65	7·5	7·631	7·761	6·965	65
70	6·5	6·065	6·361	5·635	70
75	5·4	4·293	4·962	4·420	75

N.

FIVE PER CENT.		
	a	b
Age.	12 country and 3 Parisian Parishes, 1779. Dupré and St Cyran.	Northampton Table, 1783. Dr Price.
10	15·40	15.139
15	14·82	14·588
20	14·15	14·007
25	13·59	13·567
30	12·96	13·072
35	12·32	12·502
40	11·72	11·837
45	11·05	11·105
50	10·15	10·269
55	8·93	9·382
60	7·73	8·392
65	6·73	7·276
70	5·74	6·023
75	4·59	4·744

O.

SIX PER CENT.			
a	b	c	
Breslaw Bills, 1693. Halley.	Demoivre's Hypothesis, 1753. Dodson.	Northampton Table, 1783. Price.	Age.
13·44	12·839	13·285	10
13·33	12·586	12·857	15
12·78	12·301	12·398	20
12·27	11·978	12·063	25
11·72	11·610	11·682	30
11·12	11·189	11·236	35
10·57	10·704	10·705	40
9·91	10·144	10·110	45
9·21	9·492	9·417	50
8·51	8·729	8·670	55
7·60	7·831	7·820	60
6·54	6·770	6·841	65
5·32	5·508	5·716	70
	4·000	4·542	75

Explanation of Table A.

The sign (+) after the number of lives and of deaths in column *a* signifies that the real number was greater than is there stated. Those stated were the numbers of the nominees in the two tontines which commenced in 1689 and 1696, the particulars of which have been given by M. Deparcieux; but he also made all the use he could of the tontine which commenced in 1734 (less than eight years before his observations terminated), without stating any of the numbers in his essay. And whatever may have been the whole number of nominees, or of their deaths, which he availed himself of in this tontine, M. Deparcieux's observations were actually made on so many more than 9260 nominees, and 7933 deaths, among them.

The number of persons living in the two Carlisle parishes at the end of the observations was 8677; but besides them, the observations were made upon the 1840 persons who died in the place in the term of nine years during which they were continued; and these numbers together amount to 10,517, the greatest number stated in column *b*. But the real number the observations were made upon was greater still, by the number who left the place and did not return during the observations, which is the reason of the mark (+) being put after 10,517 in column *b*.

For information respecting the number of lives insured, and of deaths, in the Equitable Assurance Society, given at the head of column *c*, the reader is referred to the note at the end of this historical introduction.

The better to enable the reader to judge of the comparative extent of the observations made upon the nominees in tontines, and other annuitants, by M. Deparcieux and Mr Finlaison, and of those made upon the population of the two Carlisle parishes, the lives insured in the Equitable Society, and the population of Sweden and Finland, the mean number of living annuitants has been assumed to have been an arithmetical mean proportional between the numbers of them at the commencement and at the end of the term, which can only be precisely true if they died off by equal numbers in equal times; and that is the reason why the double sign (±) has been placed after the mean number of the nominees or other annuitants in each column. Thus 2860± in column *d* shows that the mean number of living nominees of that description was 2860 *more or less*. The deviation from precision in this case is of no importance.

The values in column *a* have been taken from the work on Annuities of Mr Baron Maseres; those in columns *d* and *e* from Mr Finlaison's report (obs. 4 and 5); that in column *f* at each age to 50 inclusive is a mean between those in columns *d* and *e*;—after 50 they are taken from Mr Finlaison's 5th observation. The value in column *g* at each age is a mean between the two against the same age in columns *e* and *f* of table B; the values in column *i* are from Mr Finlaison's first observation.

Of Table B.

The values in columns *e* and *f* have been taken from the 20th and 13th observations respectively in Mr Finlaison's report, and were calculated from the rates of mortality for the two sexes, which have been adopted for use by government.

They were deduced from observations on the mortality among the nominees in the three Irish tontines which commenced in 1773, 1775, and 1778 respectively, on the tontine of 1789, and those of the sinking fund from 1808 to 1822.

It will be observed that the excess of the value of an annuity on a female life above that of a male is, according to the table for Sweden, in many cases not half, and in some less than one third as much as according to Mr Finlaison's, derived from the government annuitants. The cause of this cannot but be an object of interest, and deserves further investigation. It may arise in great measure from the ages of many females being stated below the truth in the Swedish returns, while they were accurately ascertained among the government annuitants.

Of Tables M, N, *and* O.

The values according to Demoivre's hypothesis were taken from Dodson's *Mathematical Repository* (vol. ii. p. 169); those in column *d* of table M, founded upon Duvillard's table of mortality for France before the Revolution, published in his work on the *Mortality from Small-Pox* (4to, Paris, 1806), were taken from *The Doctrine of Compound Interest* by M. Corbaux (8vo, London, 1825); the values according to Dupré and St Cyran from the *Calculs des Rentes Viagères* of the latter.

The authorities for the rest appear sufficiently from the preceding historical sketch.

The values of annuities according to M. Kersseboom's table of mortality are not given here, that table being of doubtful character, as he neither published the whole of the *data* from which he formed it, nor explained the manner of its construction.

It would have been desirable to include the values according to the tables of Dr Halley for Breslaw, and Dupré de St Maur for the Parisian and French country parishes in table M; but as the values of annuities have not been calculated from these tables at four *per cent.*, we have added tables N and O, and have given in each of them the values from the Northampton table, with the view of facilitating the comparison of the values in N and O with those in M and A.

Observations on the above Tables.

All the tables of mortality from which the values of annuities in tables M, N, and O, have been deduced, were calculated from *bills of mortality alone* of places where the population was variable, and the numbers of the people at the different ages were not ascertained. And therefore, notwithstanding the attempts to supply their defects, which were made by the eminent mathematicians who constructed them, none of them represented truly the laws of mortality in the places where the respective observations were made; as will be evident to those who understand the article on the *Law of Mortality* in this work, and pay the necessary attention to the materials and manner of construction of those tables. Consequently the values of annuities derived from them cannot be correct, but will in general be considerably less than the truth, even for the general average of the whole population of the places in which the observations were made.

But those values of annuities are also objectionable on this ground—that the places they were intended for, and understood to be adapted to, were generally populous towns, containing a large proportion of poor persons dependent upon their daily labour for their supply of food from day to day, often with little forethought, and many of them engaged in unwholesome employments, amongst whom great distress is often endured by the comparatively high prices of bread and potatoes, or the low rate of wages, when the unwholesome and scanty food they are reduced to produces typhus fever, and sometimes the dysentery among them, which carry them off in great numbers And these visitations were much more common at the times when the observations were made from which most of those tables were constructed, than they have been of late years.

None of those causes of mortality operate sensibly upon the general average of those persons upon whose lives leases or annuities, and reversions or assurances, depend, they being generally in the higher and middle classes. Neither do they produce much effect among the more deserving persons in the lower class, such as the members of friendly societies, and others who are both industrious and frugal enough to live within their incomes; nor indeed upon any who are in comfortable circumstances.

Hence it follows that the values of life-annuities, and, consequently, those of any pecuniary interests dependent upon the continuance or the failure of human life, cannot be correctly determined from observations made on a whole population similar to those of the places these tables were constructed from.

But this was not distinctly seen till of late years, and appears to be very imperfectly understood at present (in the year 1830), even by some who might be expected to possess correct information on the subject.

The tables constructed by Dr Price, both from the Swedish observations, and those made by Dr Haygarth at Chester, threw valuable light on this subject. But deficient crops in Sweden operate powerfully in raising the mortality there, in comparison with the more fruitful parts of Europe; therefore, the values of annuities copied into table B, and col. *h* of table A, from Dr Price's work, must only be understood as sufficiently correct for the period and place in which the observations were made. And the Chester table is in some degree liable to the same objections as the others above mentioned.

On Table A.

For nearly 70 years after its publication, M. Deparcieux's table, from which the values given in col. *a* of table A were derived, was the only one from which the values of life-interests and of reversions depending upon lives could be determined with considerable accuracy. But the comparatively high values of annuities according to that table were always supposed to arise from the careful selection of the lives; notwithstanding that they were almost all inhabitants of Paris and its environs.[1] At that time (1689–1696) the Parisians were much worse lives than during the last 50 years, and a judicious selection was much less likely to be made then than now.

It is to be regretted that the Carlisle observations were only continued nine years, commencing with 1779; but the less so since Mr Milne has shown in his work on annuities (p. 429), that during the term of 22 years commencing with 1779, the proportion of the annual average number of deaths to the mean number of the people was the same as in these first nine years, viz. that of 1 to 40.

In comparing the values in column *c* of table A with the rest, it should be borne in mind that a great majority of insured lives are males, on which account the values are somewhat lower, especially from 15 to 55 years of age, than they would have been had there been nearly equal numbers of both sexes.

Columns *d* and *e* are very instructive. In the session of 1789, an act (29 Geo. III. cap. 41) was passed for raising the sum of L.1,002,500 by the sale of shares in a tontine; but the scheme did not succeed, the persons who in the first instance had taken the whole of the shares with the expectation of selling them at a profit not having been able to dispose of half of them; and to afford those persons relief, an act (30 Geo. III. cap. 45) was passed in the next session, allowing them, before the 20th September of that year (1790), to exchange each of the tontine shares they had not been able to dispose of, for an annuity-certain payable during $69\frac{1}{4}$ years. And in order that those who had taken shares, and fixed upon their nominees in the tontine, might be placed in the same situation with regard to the benefit of survivorship as if the scheme had completely succeeded, this act empowered the commissioners of the treasury to select tontine nominees for the exchanged shares, from *the Peers of Great Britain and Ireland, their children or grandchildren; baronets, lords of manors, justices of the peace in England and Wales, or their children; the dignitaries of the church or beneficed clergy, fellows of colleges, the governors of the Charter House, the Foundling Hospital, or Christ's Hospital, and those who were registered in the books of the Amicable Life Assurance Society.*

The commissioners of the treasury were to distribute their nominees into six classes according to their ages, in proportion to the nominees of the contributors in the same classes. Tickets with the names of the nominees were then to be put into six boxes, set apart for the respective classes, and drawn out till a sufficient number to complete the tontine was obtained for each class. All of which was performed accordingly.

The values of annuities on the lives chosen by the contributors are given in col. *d*, on those thus drawn by lot in col. *e*, and the two combined in col. *f*.

Thus it appears that, of the lives in col. *e*, there was no selection except their being taken from the descriptions of persons above mentioned, who were all in the upper or middle classes of society. But, as might have been anticipated, a considerable majority of female lives were chosen by the contributors, and a considerable majority of males were drawn by the commissioners of the treasury, the descriptions of persons they were restricted to, consisting principally of males.

It will be observed that the values in columns *d* and *e* agree very nearly:—they would probably have agreed better still had the proportion of the two sexes been the same in both.

And this shows how little advantage the contributors derived from choosing their nominees, beyond what was secured to them by the classes of society they were selected from.

The values of annuities in column *i* are much less than in any other of table A; they are even less than those derived from the Northampton table of mortality.

But it would be equally precipitate and unphilosophical to conclude from thence, without further investigation, that the bulk of the people of England 100 years ago were so much shorter lived than they are now.

That the prolongation of life among the bulk of the population, from and after every age, has been very considerable during the last century, no unprejudiced person who has paid sufficient attention to the subject to qualify himself for judging of it can entertain a doubt; or that it has also been somewhat lengthened among the upper and middle classes of society; but not nearly to the extent which a comparison of columns *g* and *i* of table A would seem to imply.

There is certainly no rational ground for supposing that the physical constitution of man has altered: any change that has taken place can only have been produced by changes in the habits of the people, and the circumstances in which they have been placed.

All this might have been reasonably concluded in the absence of further information; but an examination of the circumstances under which the tontine of 1693 was

[1] As M. Deparcieux states in his *Essai*, p 62.

formed, and of the first observation in Mr Finlaison's report, from which the values in col. *i* have been deduced, will confirm it.

In that year, the same in which Dr Halley's paper on the Breslaw Bills was published in the *Philosophical Transactions*, this branch of knowledge was in its infancy. By the 22d section of the act (4 William and Mary, cap. 3) for raising a million of money by the sale of shares in this tontine, it was enacted that, if the sale of the tontine shares did not produce the whole sum wanted by the first of May 1693, then between that day and the 29th September following, for any sum contributed towards the completion of the million, the contributor should receive 14 *per cent. per annum* on such sum during the life of any person he might choose to nominate; the common interest of money at that time being 6 *per cent. per annum*. And by an act passed in the next session (5 William and Mary, cap. 5), the term for granting annuities on these terms, and for the same purpose, was extended to the 1st of May 1694. This was selling annuities at half their true value.

The age of a nominee is never mentioned in either of these acts, and those in the tontine were not distinguished into classes. These things were, at the same time, managed better in France.

Even Dr Halley was not aware of the greater mortality of males, and the consequent greater proportion of females in the population, as appears by his paper above mentioned; for after calculating from his table of mortality the number of inhabitants in Breslaw between 18 and 56 years of age to be 18,053, he says, " at least one half of these are males."

The contributors to the tontine could not be expected to be better informed on these subjects than the parliament and Dr Halley; and, with respect to ages and sexes, the following appears by Mr Finlaison's statement to have been their selection of nominees.

Aged.	Number of		
	Males.	Females.	Both.
Under 6	178	113	291
Between 6 and 11	178	118	296
Under 11	356	231	587
Between 11 and 16	119	96	215
Under 16	475	327	802
Between 16 and 21	49	39	88
Under 21	524	366	890
Above that age	70	42	112
Total	594	408	1002

In the absence of better information, it would seem reasonable to conclude that the younger a life was, the longer it would be likely to last; and accordingly we find that more than half the lives were under 11 years of age at the time of their nomination. And as males are more robust than females, it was also natural to conclude that a less rate of mortality would prevail among them; and accordingly three fifths of the nominees were males.

But subsequent observations have shown that, in both instances, the contributors made a bad choice.

Besides, of all the nominees, only one ninth had completed their 21st year at the time of their nomination. Not only the constitutions of these young nominees were not then fully formed or developed, but the mortality among them would depend greatly upon their destiny in after-life, or the circumstances of their respective situations, and upon their moral conduct: all of which must be very uncertain, and difficult to judge of at such early ages.

It is not improbable, too, that, on account of their beauty and healthy appearance, many children of scrofulous constitutions were selected; and they, on an average, would be short-lived.

It is probable that a great majority of the contributors, and therefore of their nominees, resided in London or other large and crowded towns, which have always been peculiarly unfavourable to the health of children, but were much more so then than they are now.

All circumstances considered, there appears sufficient evidence to show that the mortality among these nominees must have been much greater than among the general average of selected lives, or the general average of the people in comfortable circumstances at that time; and that, if the nominees in the English tontine of 1693 had been distributed into classes according to their ages, and a larger annuity for the same purchase-money had been allowed to the older classes, always with benefit of survivorship, the lives would have been more judiciously chosen, and would not probably have differed materially from the nominees in the French tontines of 1689 and 1696, which M. Deparcieux's observations were made upon,—they, it has been shown, were but little inferior in goodness to our present annuitants and insured lives.

The values of annuities on single lives given in Mr Finlaison's report are only specimens at one rate of interest of the results of calculations made at several rates. And extensive calculations have also been made at the Government Life-Annuity Office, of the values of annuities on two and on three joint lives, with distinction of the sexes. But none of these have been published, nor do they now (in July 1830) at that office grant any annuity depending upon more than one life, nor expect to do so for two or three years to come.

In this country, cases are continually occurring, in which an equitable adjustment of the rights and interests of different parties in property depending upon the continuance or the failure of human life, is of great importance; and in many cases it cannot be made with sufficient accuracy without tables of the values of all possible combinations of two and even of three joint lives of different ages and of both sexes. But not unfrequently, especially in cases of contingent reversions, we have been hitherto, and are still, obliged to use approximations to the values of all the possible combinations of the lives involved, not only with each other, but also of them with others one year younger than each of them respectively. In these cases it sometimes happens that the whole value sought, being but a small part of a year's purchase, is less than the probable error of several of these approximations considered separately; and then it is very difficult to give with confidence even a near approximation to the value sought.

But in a great many other cases of frequent occurrence and less difficulty, the want of a complete set of good tables of this kind is much felt. It is therefore highly desirable that, numerous calculations for them having been made at the expense of the public, they should be completed at the public expense, and rendered accessible to persons having occasion to use them; by printing, if the expense would not be too great; otherwise, by having several manuscript copies accurately made, and deposited in convenient places for inspection, upon payment of a small fee.

A few writers on these subjects, of late years, have employed the differential and integral calculus in their in-

History. vestigations. We have not yet seen any fruits of this application of the calculus which appear to us of much value, nor are we at all sanguine in expecting any.

Although Lambert and Duvillard had made some efforts in this way before, Laplace (in his *Théor. Anal. des Probabilités*, No. 40) was the principal writer who thus treated the subject, and that very shortly, merely touching upon the elements. He arrived in the usual manner at the same formulæ that are given in the elementary algebraic method, and are here demonstrated by common arithmetic; only expressed in the manner of the higher calculus, in terms of the absciss and ordinate of the curve of mortality, both considered as variable quantities.

He judiciously observed that the integral might be obtained in every case by calculating all its terms from a table of mortality, and taking their sum; and that in this manner tables of the values of annuities on single and joint lives might be calculated; which is only reverting to the usual method.

But he also observed that the same thing might be effected by describing a parabolic curve through the vertices of the two extreme and several intermediate ordinates of the curve of mortality, and even that a few of these would be sufficient, since the differences between the different tables of mortality would justify us in considering that method to be equally exact with those tables themselves. And in this we should entirely concur with that profound mathematician, provided we could admit that those tables, or most of them, had equal titles to our confidence, which he appears tacitly to assume.

But here it is that M. Laplace appears to us to have fallen into the same error as most others respecting those tables of mortality, from not having paid sufficient attention to the data they were constructed from, and the manner of their construction.

After what has been advanced in this article, and in that on the *Law of Mortality* in this work, we think it quite unnecessary to say more here, than that we consider it an History. established truth, that tables of mortality well constructed from proper *data*, for determining the values of annuities and reversions, do not differ materially from each other.

If imperfect data for constructing a table of mortality be obtained, and any one already constructed, or the mean of several of them, be taken as a pattern or standard, to which it is desired that the new table should approach, it will not be difficult, by the known methods of approximation and interpolation, so to construct such new table that it shall not differ much from the standard; but such new table, being in a certain degree hypothetical, can be of little or no value.

According to the usual methods of treating these subjects, and constructing accurate tables, we never depart from the observations, but are supported by them at every step: our clear and simple methods of reasoning and calculation are much superior to the data we can obtain: proper data are alone wanting to further the science at present; government only can effectually supply them, and all who take any interest in these subjects must be grieved to find that there is little or no hope of assistance from that quarter. Even if a wiser course be adopted in future, 20 years more must elapse before we can reap the benefit of it.

This is not the proper place to enter further into that part of the subject; but to those who take an interest in it, we would recommend the perusal of the minutes of evidence taken before the committee on the population bill, ordered by the House of Commons to be printed 11th May 1830; and the minutes of the committee on the recommitted bill, printed 26th May 1830; especially, in the latter, Mr Milne's letter to Mr Davies Gilbert, the chairman, in answer to an application made to him for his opinion, with Mr Rickman's marginal notes on that letter, and his observations on it in *his* letter to the chairman, which Mr Milne knew nothing of till the bill was passed.

NOTE REFERRED TO IN TWO PLACES ABOVE.

According to Mr Morgan's statements in the places here referred to, the number of members, or of assurances, or of policies, found to be in the Equitable Assurance Society, was—

At the end of the year			Reference to Mr Morgan's Statement.
1768	564	Policies	View of Rise and Progress, &c. p. 10.
1770	490	Policies	Ditto ... ditto.
1772	500+	Members	Ditto ... p. 27.
1773	734	Members	Address of 7th March 1793 ... p. 118.[1]
1776	913	Policies	Ditto of 24th April 1800 ... p. 140.
1783	1608	Members	Ditto of 7th March 1793 ... p. 118.
1786	2100+	Members	Ditto of 24th April 1800 ... p. 140.
1792	4640	Assurances	View of Rise and Progress, &c. p. 24.
1799	5124	Members	Ditto ... p. 26.

From which we infer, that if, at the end of each year, beginning with 1770, and ending with 1799, the number had been taken, the sum of all the 30 would have been 75,664, and the mean number during these 30 years 2522.

In a note on p. 443, vol. ii. of Dr Price's *Obs. on Rev. Paym.* (7th edit.), Mr Morgan states, that during 33 years, from January 1768 to January 1801, the number of assurances on single lives had been 83,201; but this great number can only be the sum of the 33 annual numbers as above mentioned, and the mean of these will be 2521.

What we wish to know is, the mean number of lives insured on which policies were in force during the observations; but that Mr Morgan never mentions. As more policies than one are not unfrequently granted for so many distinct assurances on the same life, neither the number of policies nor of assurances will answer our purpose; neither will the number of members, for if a policy be granted to A for insurance on the life of B, A is the member of the society, and not B, who is only the life assured, and several other members besides A may insure the life of B, while A may also hold more policies than one insuring B's life.

As has been already observed, Mr Morgan has repeatedly stated that the rate of mortality in the Equitable Society has always continued the same. And by tables *a* and *b* it appears, that out of 91,512 living persons in a similar society above 20 years of age, 1489 would die annually; also, in the table at the end of Mr Morgan's annuities (2d ed.), it is stated, that during the first 20 years of the 19th century, 1923 of the lives assured in the society died above 20 years of age; but 1489 : 1923 :: 91,512 : 118,185, so that this last is the number of lives in a similar society, out of which these 1923 deaths would happen in one year.

[1] These addresses are printed at the end of the deed of settlement of the society, for the use of the members: the copy quoted from was printed in 1801.

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Then supposing, what is probably near the truth, that under 10 years of age the number of policies was the same as that of the lives insured, we shall have, by the statement last mentioned,

	Number of Lives.	Number of Annual Deaths.
Between 10 and 20 years of age	1,494	7
Above 20	118,185	1923
Above 10 years of age	119,679	1930

And $\frac{119,679}{20} = 5984$ is the mean number above 10.

That is, a population falling short of 6000, instead of exceeding 150,000, as stated by Mr Morgan.

But by the table above mentioned in Mr Morgan's work on annuities, and the explanations of it given above, it appears that by 151,754 policies in force in the society,
119,679 lives were insured;
and 119,679 : 151,754 :: 7 : 9 nearly (more nearly :: 11 : 14). So that the number of lives was to that of the policies as 7 to 9 nearly, during the twenty years ending with 1820

On p. 61 of his pamphlet *On the Rise and Progress of the Equitable Society*, Mr Morgan states the proportion in 1827 to have been that of 3 to 4 nearly; and from another statement of his in a note on p. 42 of the same pamphlet, it would appear to have been that of 5 to 6 during the 12 years ending with 1827. The proportion above stated is nearly a mean between these two.

Taking the mean number of lives on which assurances were in force in the Equitable Society during the last 30 years of the eighteenth century to have been 2522, as determined above; since 119,679 : 2522 : : 1930 : 40·671, this last is the annual average number of deaths in the society during these 30 years; therefore the whole number of them must have been 1220, which being added to 5124, the greatest number living at any one time during the term (that is, at the end of 1799, as stated above), the sum is 6344. And the greatest number of lives on which Mr Morgan's observations were made during that term must have exceeded this, by the number who went out of the society by sale or forfeiture of the assurances, or by the expiration of the limited terms some of them were granted for, and did not enter it again; wherefore the sign (+) is added as before in table A.

In treating of Annuities, we think that it may be useful in a work of this kind to address ourselves as well to those readers who have not, as to those who have, an acquaintance with *Algebra;* and we shall accordingly divide what follows into two Parts, corresponding to these two views of the subject.

PART I.

We shall in this Part demonstrate all that is most useful and important in the doctrine of annuities and assurances on lives, without using algebra or introducing the idea of probability; but the reader is of course supposed to understand common arithmetic. In the first 30 numbers of this Part, *compound interest* and *annuities-certain* are treated of; from the 31st to the 76th the doctrine of *annuities on lives* is delivered; and that of *assurances* on lives from thence to the 108th, where the popular view terminates.

What is demonstrated in this Part will be sufficient to give the reader clear and scientific views of the subjects treated, and, with the assistance of the necessary tables, will enable him to solve the more common and simple problems respecting the values of annuities and assurances. He will also understand clearly the general principles on which problems of greater difficulty are resolved; but these he cannot undertake with propriety when the object is to make a fair valuation of any claims or interests, with a view to an equitable distribution of property, unless he has studied the subject carefully, with the assistance of algebra; for intricate problems of this kind can hardly be solved without it; and those who are not much exercised in such inquiries often think they have arrived at a complete solution, while they have overlooked some circumstance or event, or some possible combination of events or circumstances, which materially affects the value sought. Eminent mathematicians have in this way fallen into considerable errors, and it can hardly be doubted that those who are not mathematicians must (*cæteris paribus*) be more liable to them.

I.—On Annuities-Certain.

No. 1 When the rate is 5 *per cent.*, L.1 improved at simple interest during one year will amount to L.1·05; which, improved in the same manner during the second year, will be augmented in the same ratio of 1 to 1·05: the amount then will therefore be $1·05 \times 1·05$, or $(1·05)^2 = 1·1025$.

In the same manner it appears that this last amount, improved at interest during the third year, will be increased to $(1·05)^3 = 1·157625$; at the end of the fourth year it will be $(1·05)^4$; at the end of the fifth $(1·05)^5$, and so on; the amount at the end of any number of years being always determined by raising the number which expresses the amount at the end of the first year to the power of which the exponent is the number of years. So that when the rate of interest is 5 *per cent.*, L.1 improved at compound interest will in seven years amount to $(1·05)^7$, and in 21 years to $(1·05)^{21}$.

But if the rate of interest were only 3 *per cent.*, these amounts would only be $(1·03)^7$ and $(1·03)^{21}$ respectively.

2. The present value of L.1 to be received certainly at the end of any assigned term, is such a less sum as, being improved at compound interest during the term, will just amount to one pound. It must therefore be less than L.1, in the same ratio as L.1 is less than its amount in that time; but in three years at 5 *per cent.* L.1 will amount to L.$(1·05)^3$ (1). And $(1·05)^3 : 1 :: 1 : \frac{1}{(1·05)^3}$, so that $\frac{1}{(1·05)^3} = \frac{1}{1·157625} = 0·863838$ is the present value of L.1 to be received at the expiration of three years.

In the same manner it appears that, at 4 *per cent.* interest, the present value of L.1 to be received at the end of a year is $\frac{1}{1·04} = 0·961538$; and if it were not to be received until the expiration of 21 years, its present value would be $\frac{1}{(1·04)^{21}} = (0·961538)^{21} = 0·438834$.

Hence it appears, that if unit be divided by the amount of L.1 improved at compound interest during any number of years, the quotient will be the present value of L.1 to be received at the expiration of the term; which may also be obtained by raising the number which expresses the present value of L.1 receivable at the expiration of a year, to the power of which the exponent is the number of years in the term.

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3. When a certain sum of money is receivable annually, it is called an *Annuity*, and its *quantum* is expressed by saying it is an annuity of so much; thus, according as the annual payment is L.1, L.10, or L.100, it is called an annuity of L.1, of L.10, or of L.100.

4. When the annual payment does not depend upon any contingent event, but is to be made certainly, either in perpetuity or during an assigned term, it is called an *Annuity-certain*.

5. In calculating the value of an annuity, the first payment is always considered to be made at the end of the first year from the time of the valuation, unless the contrary be expressly stated.

6. The whole number, and part or parts of one annual payment of an annuity, which all the future payments are worth in present money, is called *the number of years' purchase* the annuity is worth, and, being the sum of the present values of all the future payments, is also the sum which, being put out and improved at compound interest, will just suffice for the payment of the annuity. (2.)

7. Hence it follows, that when the annuity is L.1, the number of years' purchase and parts of a year is the same as the number of pounds and parts of a pound in its present value.

And throughout this article, whenever the *quantum* of an annuity is not mentioned, it is to be understood to be L.1.

8. The sum of which the simple interest for one year is L.1, is evidently that which, being put out at interest, will just suffice for the payment of L.1 at the end of every year, without any augmentation or diminution of the principal, and, being equivalent to the title to L.1 *per annum* for ever, is called the *value of the perpetuity*, or the number of years' purchase the perpetuity is worth.

But while the rate remains the same, the annual interests produced by any two sums are to each other as the principals which produce them; therefore, since $5 : 1 :: 100 : \frac{100}{5} = 20$, when the rate of interest is 5 *per cent.*, the value of the perpetuity is 20 years' purchase. In the same manner it appears, that according as the rate may be 3 or 6 *per cent.*, the value of the perpetuity will be $\frac{100}{3} = 33\frac{1}{3}$, or $\frac{100}{6} = 16\frac{2}{3}$ years' purchase; and may be found in every case, by dividing any sum by its interest for a year.

9. All the most common and useful questions in the doctrines of compound interest and annuities-certain may be easily resolved by means of the first four tables at the end of this article. Their construction may be explained by the following specimen, rate of interest 5 *per cent.*

CONSTRUCTION OF

Term.	Table IV. Amount of L.1 *per annum* improved at Interest until	Table III. Amount of L.1 improved at Interest until	Table I. Present value of L.1 to be received at	Table II. Present value of L.1 *per annum*, to be received until	Term.
	the Expiration of the Term.				
1 yr.	1·000000	1·050000	·952381	0·952381	1 yr.
2 yrs.	2·050000	1·102500	·907029	1·859410	2 yrs.
3	3·152500	1·157625	·863838	2·723248	3
4	4·310125	1·215506	·822702	3·545950	4
5	5·525631	1·276282	·783526	4·329476	5
6	6·801913	1·340096	·746215	5·075691	6
7	8·142009	1·407100	·710681	5·786372	7

10. The calculation must begin with Table III., the first number in which should evidently be 1·05, the amount of L.1 improved at interest during one year, which being multiplied by 1·05, the product is 1·025, the second number. This second number being multiplied by 1·05, the product is 1·157625, the amount at the end of three years. And so the calculation proceeds throughout the whole of the column; each number after the first being the product of the multiplication of the preceding number, by the amount of L.1 in a year. (1.)

11. The number against any year in Table I. is found by dividing unit by the number against the same year in Table III. (2); thus, the number against the term of six years in Table I. is $\frac{1}{1{\cdot}340096} = {\cdot}746215$. All the numbers in that table after the first may also be found by multiplying that first number continually into itself. (2.)

12. The number against any year in Table II., being the sum of the numbers against that and all the preceding years in Table I., is found by adding the number against that year in Table I. to the number against the preceding year in Table II.; thus, the number against four years in Table II. being

the sum of 0·822702
and 2·723248

is 3·545950.

13. If each payment of an annuity of L.1 be put out as it becomes due, and improved at compound interest during the remainder of the term, it is evident that at the expiration of the term the payment then due will be but L.1, having received no improvement at interest. That received one year before will be augmented to the amount of L.1 in a year; that received two years before will be augmented to the amount of L.1 in two years; that received three years before to the amount of L.1 in three years; and so on until the first payment, which will be augmented to the amount of L.1 in a term one year less than that of the annuity.

Hence it is manifest that the number against any year in Table IV. will be unit added to the sum of all those against the preceding years in Table III.

And therefore that the number against any year in Table IV. is the sum of those in Tables III. and IV. against the next preceding year.

Thus, the number against seven years in Table IV. being

the sum of 1·340096
and 6·801913

is 8·142009.

14. The method of construction is obviously the same at any other rate of interest.

15. All the amounts and values which are the objects of this inquiry evidently depend upon the improvement of money at compound interest; it is therefore, that the first, second, and fourth tables, all depend upon the third.

But every pound, and every part of a pound, when put out at interest, is improved in the same manner as any single pound considered separately. Whence it is obvious, that while the term and the rate of interest remain the same, both the amount and the present value, either of any sum or of any annuity, will be the same multiple, and part or parts of the amount or the present value found against the same term, and under the same rate of interest in these tables, as the sum or the annuity proposed is of L.1.

So that to find the amount or the present value of any sum or annuity for a given term and rate of interest, we have only to multiply the corresponding tabular value by

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the sum or the annuity proposed; the product will be the amount or the value sought, according as the case may be.

16 *Example* 1. To what sum will L.100 amount when improved at compound interest during 20 years, the rate of interest being 4 *per cent. per annum?*

By Table III. it appears that L.1 so improved would, at the expiration of the term, amount to L.2·191123; therefore L.100 would amount to 100 times as much, that is, to L.219·1123, or L.219. 2s. 3d.

17. *Ex.* 2. What is the present value of L.400, which is not to be received until the expiration of 14 years, when the rate of interest is 5 *per cent.?*

The present value of L.1 to be received then will be found by Table I. to be L.0·505068: L.400 to be received at the same time will therefore be worth, in present money, 400 times as much, or L.202·0272, that is, L.202. 0s. $6\frac{1}{2}$d.

18. *Ex.* 3. Required the present value of an annuity of L.50 for 21 years, when the rate of interest is 5 *per cent.*

Table II. shows the value of an annuity of L.1 for the same term to be L.12·8212; the required value must therefore be 50 times as much, or L.641·06, that is L.641. 1s. $2\frac{1}{2}$d.

19. *Ex.* 4. What will an annuity of L.10. 10s. or L.10·5 for thirty years amount to, when each payment is put out as it becomes due, and improved at compound interest until the end of the term; the rate of interest being 4 *per cent.?*

The amount of an annuity of L.1 so improved would be L.56·084938, as appears by Table IV.; the amount required will therefore be 10·5 times this, or L.588·89185, that is L.588. 17s. 10d.

20. When the interval between the time of the purchase of an annuity and the first payment thereof exceeds that which is interposed between each two immediately successive payments, such annuity is said to be *deferred* for a time equal to that excess, and to be *entered upon* at the expiration of that time.

21. If two persons, *A* and *B*, purchase an annuity between them, which *A* is to enter upon immediately, and to enjoy during a certain part of the term, and *B* or his heirs or assigns for the remainder of it, the present value of *B's* interest will evidently be the excess of the value of the annuity for the whole of the term from this time, above the value of the interest of *A*.

So that when the entrance on an annuity is deferred for a certain term, its present value will be the excess of the value of the annuity for the term of delay and continuance together, above the value of an equal annuity for the term of delay only.

22. *Example* 1. Required the value of a perpetual annuity of L.120, which is not to be entered upon until the expiration of 14 years from this time, reckoning interest at 3 *per cent.*

The perpetuity, with immediate possession, would be worth $33\frac{1}{3}$ years' purchase (8); and an annuity for the term of delay is worth 11·2961 (Table II.)

From	33·3333
subtract	11·2961, and multiply
the remainder	22·0372
by	120
the product,	2644·464 = L.2644. 9s. $3\frac{1}{4}$d.,

is the required value.

23. *Ex.* 2. Allowing interest at 5 *per cent.*, what sum should be paid down now, for the renewal of 14 years lapsed in a lease for 21 years of an estate producing L.300 *per annum*, clear of all deductions?

This is the price of an annuity for 14 years, to be entered upon 7 years hence; the term of delay, therefore, is 7 years, and that of the delay and continuance together 21 years.

By Table II. it appears, that the present value of an annuity

for 21 years, is	12·8212	years' purchase.
for 7 years,	5·7864	
Value of the deferred annuity,	7·0348	
Multiply by	300	
The product,	L.2110·44, or L.2110. 8s. $9\frac{1}{2}$d.,	

is the price required.

24. Hitherto we have proceeded upon the supposition of the annuity being payable, and the interest convertible into principal, which shall reproduce interest, only once a year.

But annuities are generally payable half yearly, and sometimes quarterly; and the same circumstances that render it desirable for an annuitant to receive his annual sum in equal half-yearly or quarterly portions, also give occasion to the interest of money being paid in the same manner.

But whatever has been advanced above concerning the present value or the amount of an annuity, when both that and the interest of money were only payable once a year, will evidently be true when applied to half the annuity and half the interest paid twice as often, on the supposition of half-yearly payments; or to a quarter of the annuity and a quarter of the interest paid four times as often, when the payments are made quarterly.

25. Half-yearly payments are, however, by far the most common; and these four tables will also enable us to answer the most useful questions concerning them.

For we have only to extract the present value, or the amount, from the table, against twice the number of years in the term, at half the annual rate of interest, and, in the case of an annuity, to multiply the number so extracted by half the annuity proposed.

26. *Ex.* 1. To what sum will L.100 amount in 20 years, when the interest at the rate of 4 *per cent. per annum* is convertible into principal half-yearly?

This being the amount in 40 half years at 2 *per cent.* interest for every half year, will be the same as the amount in 40 years at 2 *per cent. per annum*, which, by Table III. will be found to be 220·804, or L.220. 16s. 1d.; and is only L.1. 13s. 10d. more than it would amount to if the interest were not convertible more than once a year. (16.)

27. *Ex.* 2. What is the present value of an annuity of L.50 for 21 years, receivable in equal half-yearly payments, when money yields an interest of $2\frac{1}{2}$ *per cent.* every half year?

By Table II. it appears, that an annuity of L.1 for 42 years, when the interest of money is $2\frac{1}{2}$ *per cent. per annum*, will be worth L.25·8206 (25); 25 times this sum, or L.645. 10s. $3\frac{1}{2}$d., is therefore the required value, and exceeds the value when the interest and the annuity are only payable once a year, by L.4. 9s. 1d. (18.)

28. The excess of an annuity-certain above the interest of the purchase-money, is the sum which, being put out at the time of each payment becoming due, and improved at compound interest until the expiration of the term, will just amount to the purchase-money originally paid.

But, while every thing else remains the same, the longer the term of the annuity is, the less must its excess above the interest of the purchase-money be, because a less annuity will suffice for raising the same sum within the term. Therefore, the proportion of that excess to the annual interest of the purchase-money continually diminishes as

the term is extended; and when the annuity is a perpetuity, there is no such excess. (8.)

29. The reason why the value of an annuity is increased by that and the interest being both payable more than once in the year, is, that the granter loses and the purchaser gains the interest produced by that part of each payment which is in excess above the interest then due upon the purchase-money, from the time of such payment being made until the expiration of the year.

Hence it is obvious, that the less this excess is, that is, the longer the term of the annuity is (28), the less must the increase of value be.

And when the annuity is a perpetuity, its value will be the same, whether it and the interest of money be both payable several times in the year, or once only.

30. When the annuity is not payable at the same intervals at which the interest is convertible into principal, its value will depend upon the frequencies both of payment and conversion; but its investigation without algebra would be too long, and of too little use, to be worth prosecuting here.

II.—Of Annuities on Lives.

31. When the payment of an annuity depends upon the existence of some life or lives, it is called a *Life-Annuity.*

32. The values of such annuities are calculated by means of tables of mortality, which show, out of a considerable number of individuals born, how many upon an average have lived to complete each year of their age, and, consequently, what proportion of those who attained to any one age have survived any greater age.

The fifth table at the end of this article is one of that kind which has been taken from Mr Milne's *Treatise on Annuities,* and was constructed from accurate observations made at Carlisle by Dr Heysham, during a period of nine years, ending with 1787.

33. By this table it appears, that during the period in which these observations were made, out of 10,000 children born, 3203 died under five years of age, and the remaining 6797 completed their fifth year. Also, that out of 6797 children who attained to five years of age, 6460 survived their tenth year.

But the mortality under ten years of age has been greatly reduced since then by the practice of vaccination.

This table also shows, that of 6460 individuals who attained to 10 years of age, 6047 survived 21; and that of 5075 who attained to 40, only 3643 survived their 60th year.

34. There is good reason to believe (as has been shown in another place) that the general law of mortality, that is, the average proportion of persons attaining to any one age, who survive any greater age, remains much the same now among the entire mass of the people throughout England, as it was found to be at Carlisle during the period of these observations, except among children under ten years of age, as was noticed above. (33.)

If this be so, it will follow, that of 6460 children now 10 years of age, just 6047 will attain to 21; or rather, that if any great number be taken in several instances, this $\left(\frac{6047}{6460}\right)$ will be the average proportion of them that will survive the period.

And if 6460 children were to be taken indiscriminately from the general mass of the population at 10 years of age, and an office or company were to engage to pay L.1 eleven years hence for each of them that might then be living, this engagement would be equivalent to that which should bind them to pay L.6047 certainly at the expiration of the term. Therefore the office, in order that it might neither gain nor lose by the engagement, should, upon entering into it, be paid for the whole, the present value of L.6047 to be received at the expiration of eleven years; and for each life the $\frac{1}{6460}$th part of it, that is, the $\frac{6047}{6460}$th part of the present value of L.1, to be received then.

But when the rate of interest is 5 *per cent.*, the present value of L.1, to be received at the expiration of 11 years, is L.0·584679; therefore, at that rate of interest, there should be paid for each life $\frac{6047 \times 0{\cdot}584679}{6460} = \text{L.}0{\cdot}5473.$

And the present value of L.100, to be received upon a life now 10 years of age attaining to 21, will be L.54·73, or L.54. 14s. 7d.

In the same manner it will be found, that reckoning interest at 4 *per cent.*, the value would be L.60. 16s. 1d.

35. This is the method of calculating the present values of endowments for children of given ages; and the values of annuities on lives may be computed in the same manner.

For, from the above reasoning it is manifest, that if the present value of L.1, to be received certainly at the expiration of a given term, be multiplied by the number in the table of mortality against the age, greater than that of any proposed life by the number of years in the term, and the product be divided by the number in the same table, against the present age of that life; the quotient will be the present value of L.1, to be received at the expiration of the term, provided that the life survive it.

And if, in this manner, the value be determined of L.1, to be received upon any proposed life, surviving each of the years in its greatest possible continuance, according to the table of mortality adapted to it; that is, according to the Carlisle table, upon its surviving every age greater than its present, to that of 104 years inclusive; then, the sum of all these values will evidently be the present value of an annuity on the proposed life.

36. If 5642 lives at 30 years of age be proposed, and 5075 at the age of 40; since each of the 5642 younger lives may be combined with every one of the 5075 that are 10 years older, the number of different pairs, or different combinations of two lives differing in age by 10 years, that may be formed out of the proposed lives, is 5642 times 5075.

But at the expiration of 15 years the survivors of the lives now 30 and 40 years of age, being then of the respective ages of 45 and 55, will be reduced to the numbers of 4727 and 4073 respectively; and the number of pairs, or combinations of two, differing in age by 10 years, that can be formed out of them, will be reduced from 5642×5075 to 4727×4073.

So that L.1 to be paid at the expiration of 15 years for each of these 5642×5075 pairs or combinations of two now existing, which may survive the term, will be of the same value in present money as 4727 times L.4073 to be received certainly at the same time.

Now, let A be any one of these lives of 30 years of age, and B any one of those aged 40; and, from what has been advanced, it will be evident that the present value of L.1, to be received upon the two lives in this particular combination jointly surviving the term, will be the same as that of the sum $\frac{\text{L.}4727 \times 4073}{5642 \times 5075}$ to be then received certainly.

But, when the rate of interest is 5 *per cent.*, L.1 to be received certainly at the expiration of 15 years, is equivalent to L.0·481017 in present money. (Table I.)

Therefore, at that rate of interest, and according to the Carlisle table of mortality, the present value of L.1 to be received upon A and B, now aged 30 and 40 years respectively, jointly surviving the term of 15 years, will be

$$\frac{4727 \times 4073 \times \text{L.}0{\cdot}481017}{5642 \times 5075}.$$

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37. Hence it is sufficiently evident how the present value of L.1 to be received upon the same two lives jointly surviving any other year may be found. And if that value for each year from this time until the eldest life attain to the limit of the table of mortality be calculated, the sum of all these will be the present value of an annuity of L.1 dependent upon their joint continuance.

In this manner, it is obvious that the value of an annuity on the joint continuance of any other two lives might be determined.

38. If, besides the 5642 lives at 30 years of age, and the 5075 at 40 (mentioned in No. 36), there be also proposed 3643 at 60 years of age, each of these 3643 at 60 may be combined with every one of the 5642×5075 different combinations of a life of 30, with one of 40 years of age; and, therefore, out of these three classes of lives $5642 \times 5075 \times 3643$ different combinations may be formed, each containing a life of 30 years of age, another of 40, and a third of 60.

But at the expiration of 15 years the numbers of lives in these three classes will, according to the table of mortality, be reduced to 4727, 4073, and 1675 respectively; the respective ages of the survivors in the several classes being then 45, 55, and 75 years; and the number of different combinations of three lives (each of a different class from either of the other two) that can be formed out of them, will be reduced to $4727 \times 4073 \times 1675$.

Hence, by reasoning as in No. 36, it will be found, that if A, B, and C be three such lives, now aged 30, 40, and 60 years, the present value of L.1 to be received upon these three jointly surviving the term of 15 years from this time, will be $\frac{4727 \times 4073 \times 1675}{5642 \times 5075 \times 3643} \times \text{L.}0{\cdot}481017$: interest being reckoned at 5 *per cent.*

Thus it is shown how the present value of an annuity dependent upon the joint continuance of these three lives might be calculated, that being the sum of the present values thus determined, of the rents for all the years which, according to the table of mortality, the eldest life can survive.

39. But it is easy to see that the same method of reasoning may be used in the case of four, five, or six lives, and so on without limit. Whence this inference is obvious.

The present value of L.1 to be received at the expiration of a given term, provided that any given number of lives all survive it, may be found by multiplying the present value of L.1 to be received certainly at the end of the term, by the continual product of the numbers in the table of mortality against the ages greater respectively by the number of years in the term than the ages of the lives proposed, and dividing the last result of these operations by the continual product of the numbers in the table of mortality against the present ages of the proposed lives.

And by a series of similar operations, the present value of an annuity on the joint continuance of all these lives might be determined.

But it should be observed, that, in calculating the value of a life-annuity in this way, the denominator of the fractions expressing the values of the several years' rents, that is, the divisor used in each of the operations, remains always the same: the division should, therefore, be left till the sum of the numerators is determined; and one operation of that kind will suffice.

40. Enough has been said to show that these methods of constructing tables of the values of annuities on lives are practicable, though excessively laborious; and, in fact, all the early tables of this kind were constructed in that manner. We proceed now to show how such tables may be calculated with much greater facility.

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41. By the method of No. 34, it will be found that, reckoning interest at 5 *per cent.*, the present value of L.1 to be received at the expiration of a year, provided that a life, now 89 years of age, survived till then, is $\frac{142 \times 0{\cdot}95238}{181}$. But the age of that life will then be 90 years, and the proprietor of an annuity of L.1 now depending upon it will, in that event, receive his annual payment of L.1 then due; therefore, if the value then of all the subsequent payments, that is, the value of an annuity on a life of 90, be 2·339 years' purchase, the present value of what the title to this annuity may produce to the proprietor at the end of the year will be the same as that of L.3·339, to be received then, if the life be still subsisting, or $\frac{142 \times 0{\cdot}952381}{181} \times \text{L.}3{\cdot}339 = \text{L.}2{\cdot}495$; which, therefore, will be the present value of an annuity of L.1 on a life of 89 years of age. That is to say, an annuity on that life will now be worth 2·495 years' purchase. (7.)

42. In the same manner it appears generally, that if unit be added to the number of years' purchase that an annuity on any life is worth, and the sum be multiplied by the present value of L.1 to be received at the end of a year, provided that a life one year younger survive till then, the product will be the number of years' purchase an annuity on that younger life is worth in present money.

43. But, according to the table of mortality, an annuity on the eldest life in it is worth nothing; therefore, the present value of L.1 to be received at the end of a year provided that the eldest life but one in the table survive till then, is the total present value of an annuity of L.1 on that life; which being obtained, the value of an annuity on a life one year younger than it may be found by the preceding number; and so on for every younger life successively.

EXEMPLIFICATION.

Rate of Interest 5 *per cent.*

Age of Life.	Value of an Annuity on that Life, increased by Unit,	Which being multiplied by 0·952381, and the Product by	Produces the value of an Annuity on the next younger Life,	Its Age being
104	1·000	$\frac{1}{3}$	0·317	103
103	1·317	$\frac{3}{5}$	0·753	102
102	1·753	$\frac{5}{7}$	1·192	101
101	2·192	$\frac{7}{9}$	1·624	100
100	2·624	$\frac{9}{11}$	2·045	99
99	3·045	$\frac{11}{14}$	2·278	98
98	3·278	$\frac{14}{18}$	2·428	97
97	3·428	$\frac{18}{23}$	2·555	96
96	3·555	$\frac{23}{30}$	2·596	95
95	3·596	$\frac{30}{40}$	2·569	94

44. Proceeding as in No. 36, it will be found that, at 5 *per cent.* interest, and according to the Carlisle table of mortality, the present value of L.1 to be received at the expiration of a year provided that a person now 89 years of age, and another now 99, be then living, is $\frac{142 \times 9 \times \text{L.}0{\cdot}952381}{181 \times 11}$; therefore, if the present value o an annuity of L.1 on the joint continuance of two lives, now aged 90 and 100 years respectively, be L.0·950, by reasoning as in No. 41, it will be found that the present value of an annuity on the joint continuance of two lives,

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of the respective ages of 89 and 99 years, will be worth $\frac{142 \times 9 \times 0{\cdot}952381}{181 \times 11} \times 1{\cdot}950 = 1{\cdot}192$ years' purchase.

45. In this manner, commencing with the two oldest lives in the table that differ in age by ten years, and proceeding according to No. 43, the values of annuities on all the other combinations of two lives of the same difference of age may be determined.

The method is exemplified in the following specimen.

Ages of two Lives.	Value of an Annuity on their joint continuance, increased by Unit,	Which being multiplied by 0·952381, and the Product by	Produces the value of an Annuity on the two joint Lives one year younger respectively,	Their Ages being
94 & 104	1·000	$\frac{1 \times 40}{3 \times 54}$	0·235	93 & 103
93 & 103	1·235	$\frac{3 \times 54}{5 \times 75}$	0·508	92 & 102
92 & 102	1·508	$\frac{5 \times 75}{7 \times 105}$	0·733	91 & 101
91 & 101	1·733	$\frac{7 \times 105}{9 \times 142}$	0·950	90 & 100
90 & 100	1·950	$\frac{9 \times 142}{11 \times 181}$	1·192	89 & 99
89 & 99	2·192	$\frac{11 \times 181}{14 \times 232}$	1·280	88 & 98

46. Hence, and by what has been advanced in the 39th number of this article, it is sufficiently evident how a table may be computed of the values of annuities on the joint continuance of the lives in every combination of three, or any greater number; the differences between the ages of the lives in each combination remaining always the same in the same series of operations, while the calculation proceeds back from the combination in which the oldest life is the oldest in the table, to that in which the youngest is a child just born.

47. But when there are more than two lives in each combination, the calculations are so very laborious, on account principally of the great number of combinations, that no tables of that kind have yet been published, except three or four for three lives.

And in the books that contain tables of the values of two joint lives, methods are given of approximating towards the values of such combinations of two and of three lives as have not yet been calculated.

Therefore, assuming the values of annuities on single lives, and on the joint continuance of two or of three lives, to be given, we have next to show how the most useful problems respecting the values of any interests that depend upon the continuance or the failure of life may be resolved by them.

48. *Proposition* 1. The value of an annuity on the survivor of two lives, *A* and *B*, is equal to the excess of the sum of the values of annuities on the two single lives above the value of an annuity on their joint continuance.

49. *Demonstration.* If annuities on each of the two lives were granted to *P*, during their joint continuance he would have two annuities; but if *P* were only to receive these upon condition that, during the joint lives of *A* and *B*, he should pay one annuity to *Q*, then there would only remain one to be enjoyed by him or his heirs or assigns, until the lives both of *A* and *B* were extinct; whence the truth of the proposition is manifest.

50. *Prop.* 2. The value of an annuity on the joint continuance of the two last survivors out of three lives, *A*, *B*, and *C*, is equal to the excess of the sum of the values of annuities on the three combinations of two lives (*A* with *B*, *A* with *C*, and *B* with *C*) that can be formed out of them, above twice the value of an annuity on the joint continuance of all the three lives.

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51. *Dem.* If one annuity were granted to *P* on the joint continuance of the two lives *A* and *B*, another on the joint continuance of *A* and *C*, and a third on the joint continuance of *B* and *C*; during the joint continuance of all the lives he would have three annuities.

But if he were only to receive these upon condition that he should pay two annuities to *Q* during the joint continuance of all the three lives, then there would only remain to himself one annuity during the joint existence of the last two survivors out of the three lives. And the truth of the proposition is manifest.

52. *Prop.* 3. The value of an annuity on the last survivor of three lives, *A*, *B*, and *C*, is equal to the excess of the sum of the values of annuities on each of the three single lives, together with the value of an annuity on the joint continuance of all the three, above the sum of the values of three other annuities; the first dependent upon the joint continuance of *A* and *B*, the second on that of *A* and *C*, and the third on *B* and *C*.

53. *Dem.* If annuities on each of the three single lives were granted to *R*, during the joint continuance of all the three he would have three annuities; and from the time of the extinction of the first life that failed, till the extinction of the second, he would have two.

So that he would have two annuities during the joint existence of the two last survivors out of the three lives; and besides these, a third annuity during the joint continuance of all the three.

Therefore, if out of these *R* were to pay one annuity to *P* during the joint continuance of the last two survivors out of the three lives, and another to *Q* during the joint continuance of all the three, he would only have left one annuity, which would be receivable during the life of the last survivor of the three.

But in the demonstration of the last proposition (51) it was shown, that the value of what he paid to *P* would fall short of the sum of the values of annuities dependent respectively on the joint continuance of *A* and *B*, of *A* and *C*, and of *B* and *C*, by two annuities on the joint continuance of all the three lives. Whence it is evident that the value of the annuities he paid both to *P* and *Q* would fall short of the sum of these three values of joint lives, only by the value of one annuity on the joint continuance of all the three lives.

Wherefore, if from the sum of the values of all the three single lives, the sum of the values of the three combinations of two that can be formed out of them were taken, there would remain less than the value of an annuity on the last survivor, by that of an annuity on the joint continuance of the three lives.

But if, to the sum of the values of the three single lives *A*, *B*, and *C*, there be added that of an annuity on the joint continuance of the three, and from the sum of these four values the sum of the values of the three combinations *A* with *B*, *A* with *C*, and *B* with *C* be subtracted, then the remainder will be the value of an annuity on the last survivor of the three lives; which was to be demonstrated.

54. *Prop.* 4. *Problem.* The law of mortality and the values of single lives at all ages being given, to determine the present value of an annuity on any proposed life, deferred for any assigned term.

55. *Solution.* Find the present value of an annuity on

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a life older than the proposed, by the number of years during which the other annuity is deferred; multiply this by the present value of L.1 to be received upon the proposed life surviving the term, and the product will be the value sought.

56. *Dem.* Upon the proposed life surviving the term, the annuity dependent upon it will be worth the same sum that an annuity on a life so much older is now worth; therefore it is evident that the deferred annuity is of the same present value as that sum to be received at the expiration of the term, provided the life survive it.

57. *Corollary.* In the same manner it appears, that the present value of an annuity on the joint continuance of any number of lives, deferred for a given term, may be found by multiplying the present value of an annuity on the joint continuance of the same number of lives, older respectively than the proposed by the number of years in the term, by the present value of L.1 to be received upon the proposed lives all surviving it.

58. A *temporary annuity* on any single life, or on the joint continuance of any number of lives, that is, an annuity which is to be paid during a certain term, provided that the single life or the other lives jointly subsist so long, together with an annuity on the same life or lives *deferred* for the same term, is evidently equivalent to an annuity on the whole duration of the same life or lives.

So that the value of an annuity on any life, or on the joint continuance of any number of lives, for an assigned term, is equal to the excess of the value of an annuity on their whole duration, with immediate possession, above the value of an annuity on them deferred for the term.

59. Whatever has been advanced from No. 48 to 53 inclusive, respecting the values of annuities for the whole duration of the lives whereon they depend, will apply equally to those which are either deferred or temporary; and therefore, to determine the value of any deferred or temporary annuity dependent upon the last survivor of two or of three lives, or upon the joint continuance of the last two survivors out of three lives, we have only to substitute temporary or deferred annuities, as the case may require, for annuities on the whole duration of the lives; and the result will accordingly be the value of a temporary or deferred annuity on the life of the last survivor, or on the joint lives of the two last survivors.

60. *Prop.* 5. *A* and *B* being any two proposed lives now in existence, the present value of an annuity to be payable only while *A* survives *B*, is equal to the excess of the value of an annuity on the life of *A* above that of an annuity on the joint existence of both the lives.

61. *Dem.* If an annuity on the life of *A*, and to be entered upon immediately, were now granted to *P* upon condition that he should pay it to *B* during the joint lives of *A* and *B*, it is evident that there would only remain to *P* an annuity on the life of *A* after the decease of *B*; whence the truth of the proposition is manifest.

62. When any thing is affirmed or demonstrated of *any life or lives*, it is to be understood as applying equally to any proposed single life, or to the joint continuance of the whole of any number of lives that may be proposed together, or to that of any assigned number of the last survivors of them, or to the last surviving life of the whole.

63. *Prop.* 6. The present value of the reversion of a perpetual annuity after the failure of any life or lives, is equal to the excess of the present value of the perpetuity, with immediate possession, above the present value of an annuity on the same life or lives.

64. *Dem.* If a perpetual annuity with immediate possession were granted to *P*, upon condition that he should pay the annual produce to another individual during the existence of the life or lives proposed, it is evident that there would only remain to *P* the reversion after the failure of such life or lives; and the present value of that reversion would manifestly be as stated above.

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65. The 6th, 7th, and 8th tables at the end of this article, which have been extracted from the 19th, 21st, and 22d respectively, in Mr Milne's *Treatise on Annuities*, will serve to illustrate the application of these propositions to the solution of questions in numbers.

In all the following examples, we suppose the lives to be such as the general average of those from which the Carlisle table of mortality was constructed, and the rate of interest to be 5 *per cent.*

66. *Ex.* 1. What is the present value of an annuity on the joint lives, and the life of the survivor of two persons now aged 40 and 50 years respectively?

According to No. 48, the process is as follows:

Value of a single life of	40	13·390	(by Table VI.)
	50	11·660	
	sum	25·050	
Subtract the value of their joint lives,		9·984	(Table VIII.)
	remains	15·066	years' purchase, the required value.

And if the annuity be L.200, its present value will be L.3013·2, or L.3013. 4s.

67. *Ex.* 2. The lives *A*, *B*, and *C*, being now aged 50, 55, and 60 years respectively, an annuity on the joint continuance of all the three is worth 6·289 years' purchase, what is the value of an annuity on the joint existence of the last two survivors of them?

According to No. 50, the process is thus:

Ages.	Values.	
50 & 55	8·528	(Table VII.)
55 & 60	7·106	
50 & 60	7·601	(Table VIII.)
sum	23·235	
Subtract 2 × 6·289 =	12·578	
remains	10·657	years' purchase, the required value.

Therefore, if the annuity were L.300, it would be worth L.3197. 2s. in present money.

68. *Ex.* 3. Required the value of an annuity on the last survivor of the three lives in the last example.

Proceeding according to No. 52, we have

Ages.	Values.	
50	11·660	(Table VI.)
55	10·347	
60	8·940	
50, 55, & 60	6·289	(No. 67).
sum	37·236	
Subtract the sum of the values of annuities on the three combinations of two lives,	23·235	(No. 67.)
remains	14·001	years' purchase,

the required value. And if the annuity were L.300, it would now be worth L.4200. 6s.

69. *Ex.* 4. What is the present value of an annuity on a life now 45 years of age, which is not to be entered upon until the expiration of ten years; the first payment thereof being to be made at the expiration of eleven years from this time, if the life survive till then?

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Solution.

The present value of an annuity on a life of 55 is 10·347 (Table VI.), and the present value of L.1 to be received upon the proposed life attaining to the age of 55, is $\frac{4073}{4727} \times 0{\cdot}613913$; therefore, by No. 55, the required value is $\frac{4073 \times 0{\cdot}613913 \times 10{\cdot}347}{4727} = 5{\cdot}473$ years' purchase; so that if the annuity were L.200, its present value would be L.1094. 12s.

70. *Ex.* 5. Required the present value of an annuity to be received for the next ten years, provided that a person now 45 years of age shall so long live.

Solution.

The present value of an annuity on a life of 45, to be entered upon immediately, is 12·648 (Table VI.)
Subtract that of an annuity on the same life deferred 10 years, } 5·473 (69.)

the remainder 7·175

is the required number of years' purchase. And if the annuity were L.200, its present value would be L.1435.

71. *Ex.* 6. An annuity on a life of 45, deferred 10 years, was shown in No. 69 to be worth 5·473 years' purchase in present money; let it be required to determine the equivalent annual payment for the same, to be made at the end of each of the next 10 years, but subject to failure upon the life failing in the term.

Solution.

The present value of L.1 *per annum* on the proposed life for the next 10 years has just been shown to be L.7·175, and this, multiplied by the required annual payment, must produce L.5·473; that payment must, therefore, be $\frac{5{\cdot}473}{7{\cdot}175} = 0{\cdot}76279$. And since the annual payment for the deferred annuity of L.1 *per annum* would be L.0·76279, that for an annuity of L.200 must be L.152. 11s. 2d.

72. *Ex.* 7. Let the present value be required of an annuity on a life now 40 years of age, to be payable only while that life survives another now of the age of 50 years.

From the present value of a life of 40, } 13·390 (Table VI.)
Subtract that of the two joint lives, } 9·984 (Table VIII.)

the remainder, 3·406

years' purchase, is the required value. (60.)

Therefore, if the annuity were L.100, it would be worth L.340. 12s. in present money.

73. If the annuity in the last example were to be paid for by a constant annual premium at the end of each year while both the lives survived; by reasoning as in No. 71, it will be found, that such annual premium for an annuity of L.1 should be $\frac{3{\cdot}406}{9{\cdot}984} =$ L.0·341146; for an annuity of L.100 it should therefore be L.34. 2s. 3½d.

74. But if one of the equal premiums for this annuity is to be paid down now, and another at the end of each year while both the lives survive, the number of years' purchase the whole of these premiums are worth will evidently be increased by unit; on account of the payment made now, it will therefore be 10·984; and each premium for an annuity of L.1 must, in this case, be $\frac{3{\cdot}406}{10{\cdot}984} =$ L.0·310087; for an annuity of L.100 it should therefore be L.31. 0s. 2d.

75. *Ex.* 8. Let it be required to determine the present value of the reversion of a perpetual annuity after the failure of a life now 50 years of age.

Solution.

The value of the perpetuity is 20 years' purchase. (8.)
Subtract that of an annuity on the life of 50, } 11·660 (Table VI.)

remains 8·34 years' purchase,

the required value of the reversion. (63.)

So that if the annuity were L.300, its present value would be L.2502.

76. In the same manner it will be found, by the 68th number and those referred to in the last example, that the reversion of a perpetuity, after the failure of the last survivor of three lives, now aged 50, 55, and 60 years respectively, is worth 5·999 years' purchase in present money; therefore, if it were L.100 *per annum*, its present value would be L.599. 18s.

III.—Of Assurances on Lives.

77. An assurance upon a life or lives is a contract by which the office or underwriter, in consideration of a stipulated premium, engages to pay a certain sum upon such life or lives failing within the term for which the assurance is effected.

78. If the term of the assurance be the whole duration of the life or lives assured, the sum must necessarily be paid whenever the failure happens; and, in what follows, that payment is always supposed to be made at the end of the year in which the event assured against takes place; the anniversary of the assurance, or the day of the date of the policy, being accounted the beginning of each year.

79. At the end of the year in which any proposed life or lives may fail, the proprietor of the reversion of a perpetual annuity of L.1 after their failure will receive the pound then due, and will at the same time enter upon the perpetuity; therefore, the present value of the reversion is the same as that of L.1 added to the money a perpetual annuity of L.1 would cost, supposing this sum not to be receivable until the expiration of the year in which the failure of the life or lives might happen.

80. Hence we have this proportion. As the value of a perpetuity increased by unit is to L.1, so is the present value of the reversion of a perpetual annuity of L.1, after the failure of any life or lives, to the present value of L.1, receivable at the end of the year in which such failure shall take place.

81. Therefore, *if the value of an annuity of one pound on any life or lives be subtracted from that of the perpetuity, and the remainder be divided by the value of the perpetuity increased by unit, the quotient will be the value, in present money, of the assurance of one pound on the same life or lives.* (63.)

82. *Ex.* 1. What is the present value of L.1 to be received at the end of the year in which a life now 50 years of age may fail?

The rate of interest being 5 *per cent.*, the value of the perpetuity is 20 years' purchase, and that of the life 11·66; the answer therefore is $\frac{20-11{\cdot}66}{20+1} = \frac{8{\cdot}34}{21} =$ L.0·397143. And if the sum assured were L.1000, the present value of the assurance would be L.397. 2s. 10d.

83. When the term of a life-assurance exceeds one year, its whole value is hardly ever paid down at the time that the contract is entered into; but in the instrument (called a policy) whereby the assurance is effected, an equivalent annual premium is stipulated for, payable at the *commence-*

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ment of each year during the term, but subject to failure with the life or lives assured.

84. But by reasoning as in No. 74, it will be found that an annual premium, payable at the *commencement* of each year in the whole duration of the life or lives assured, will be worth one year's purchase more than an annuity on them payable at the *end* of each year; and, consequently, that if the value in present money of an assurance on any life or lives be divided by the number of years' purchase an annuity on the same life or lives is worth, increased by unit, the quotient will be the equivalent annual premium for the same assurance.

85. *Ex.* 2. Required the annual premium for the assurance of L.1 on a life of 50 years of age.

In No. 82 the single premium for that assurance was shown to be 0·397143, and the value of an annuity on the life is 11·66; therefore, by the preceding number, the required annual premium will be $\frac{0 \cdot 397143}{12 \cdot 66} = \cdot 0313699$ for the assurance of L.1; and for the assurance of L.1000 it will be L.31. 7s. 5d.

86. *Ex.* 3. Let both the single payment in present money, and the equivalent annual premium, be required for the assurance of L.1, on the joint continuance of two lives of the respective ages of 45 and 50 years.

The value of an annuity of L.1 on the joint continuance of these two lives appears by Table VII. to be L.9·737, therefore $\frac{20-9 \cdot 737}{20+1} = \frac{10 \cdot 263}{21} =$ L.0·488714 is the single premium, and $\frac{0 \cdot 488714}{10 \cdot 737} =$ L.0·0455168 the equivalent annual one, for the assurance of L.1 to be paid at the end of the year in which that life becomes extinct which may happen to fail the first of the two.

Therefore, if the sum assured were L.500, the total present value of the assurance would be L.244. 7s. 2d., and the equivalent annual premium L.22. 15s. 2d.

87. *Ex.* 4. Let both the single and the equivalent annual premium be required for the assurance of L.1 on the life of the survivor of two persons now aged 40 and 50 years respectively.

The value of an annuity on the survivor of these two lives was shown in No. 66 to be 15·066, therefore, by No. 81, the single premium will be $\frac{20-15 \cdot 066}{20+1} = \frac{4 \cdot 934}{21}$ = L.0·234952; and, by No. 84, the annual one will be $\frac{\text{L.}0 \cdot 234952}{16 \cdot 066} =$ L.0·0146242.

That is, for the assurance of L.1 to be received at the end of the year in which the last surviving life of the two becomes extinct.

Therefore, for the assurance of L.5000, the single premium will be L.1174. 15s. 2d., the equivalent annual one L.73. 2s. 5d.

88. *Ex.* 5. What should the single and equivalent annual premiums be for an assurance on the last survivor of three lives of the respective ages of 50, 55, and 60 years?

The value of an annuity on the last survivor of them was shown in No. 68 to be 14·001, the single premium should therefore be $\frac{20-14 \cdot 001}{20+1} = \frac{5 \cdot 999}{21} =$ L.0·285666, and the annual $\frac{\text{L.}0 \cdot 285666}{15 \cdot 001} =$ L.0·0190431, for the assurance of L.1 to be received at the end of the year in which the last surviving life of the three may fail.

For the assurance of L.2000, the single premium would therefore be L.571. 6s. 8d., the annual one L.38. 1s. 9d.

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89. *Lemma.* If an annuity be payable at the *commencement* of each year which some assigned life or lives may *enter upon* in a given term, the number of years' purchase in its present value will exceed by unit the number of years' purchase in the present value of an annuity on the same life or lives for one year less than the given term, but payable, as annuities generally are, at the *end* of each year.

Demonstration. Since the proposed life or lives can only enter upon any year after the first by surviving the year that precedes it, the receipt of each of the payments after the first, that are to be made at the commencement of the year, will take place at the same time and upon the same conditions as that of the rent for the year then expired of the life-annuity, for a term one year less than the term proposed: this last-mentioned annuity will therefore be worth, in present money, just the same number of years' purchase as all the payments subsequent to the first which may be made at the commencements of the several years.

And since the first of these is to be made immediately, the present value of the whole of them will evidently exceed the number of years' purchase last mentioned by unit; which was to be demonstrated.

90. If, while the rest remains the same, the payment of the annuity which depends upon the assigned life or lives *entering upon* any year is not to be made until the end of that year; as the condition upon which every payment is to be made will remain the same, but each of them will be one year later; the only alteration in the value of the whole will arise from this increase in the remoteness of payment, by which it will be reduced in the ratio of L.1 to the present value of L.1 receivable at the end of a year. (2.)

91. When the value of an annuity on any proposed life or lives for an assigned term is given, it is evident that the value of an annuity on the same life or lives for one year less may be found, by subtracting from the given value the present value of the rent to be received upon the proposed life or lives surviving the term assigned.

92. *Proposition.* The present value of an assurance on any proposed life or lives for a given term is equal to the excess of the value of an annuity to be paid at the end of each year which the life or lives proposed may *enter upon* in the term, above the value of an annuity on them for the same term, but dependent, as usual, upon their surviving each year.

Demonstration. If an annuity, payable at the end of each year which the proposed life or lives may enter upon during the given term, be granted to P upon condition that he shall pay over what he receives to Q at the end of each year which the same life or lives may survive, it is manifest that there will only remain to P the rent for the year in which the proposed life or lives may fail; that is, the assurance of that sum thereon for the given term (77); which was to be demonstrated.

93. From the last four numbers (89–92) we derive the following

Rule

for determining the present value of an assurance on any life or lives for a given term.

Add unit to the value of an annuity on the proposed life or lives for the given term, and from the sum subtract the present value of one pound to be received upon the same life or lives surviving the term; multiply the remainder by the present value of L.1 *to be received certainly at the end of a year, and from the product subtract the present value of an annuity on the proposed life or lives for the term.*

This last remainder will be the value in present money

of the assurance of L.1 during the same term on the life or lives proposed.

94. It has been shown above (34–39) how the present value of L.1 receivable upon any single or joint lives surviving an assigned term may be found. And all that was demonstrated from No. 48 to 53 inclusive, respecting annuities on the last survivor of two or of three lives, or on the joint continuance of the two last survivors out of three lives, is equally true of any particular year's rent of those annuities. Hence it is evident how the present value of L.1, to be received upon the last survivor of two or of three lives, or upon the last two survivors out of three lives, surviving any assigned term, may be found.

95. *Example.* Required the present value of L.1, to be received at the end of the year in which a life now forty-five years of age may fail, provided that such failure happen before the expiration of ten years.

Here the present value of L.1, to be received on the life surviving the term, will be found to be L.0·528976, and the value of an annuity on the proposed life for the term is 7·175. (70.)

From	8·175
subtract	0·528976
the remainder	7·646024
being multiplied by	0·952381
produces	7·28193
from this subtract	7·17500

remains L.0·10693, the required value of the assurance; and if the sum assured were L.3000, the value of the assurance in present money would be L.320. 15s. 7d.

96. By numbers 89, 91, and 95, it appears that an annuity, payable at the commencement of each of the next ten years that a life of 45 enters upon, is worth 7·646 years' purchase; therefore, $\frac{0\cdot10693}{7\cdot646} =$ L.0·013985 will be the annual premium for the assurance of L.1 for ten years on that life. For the assurance of L.3000, it will therefore be L.41. 19s. 1d.

97. When the term of the assurance is the whole duration of the life or lives assured, L.1 to be received upon their surviving the term is worth nothing; and an annuity on the lives for the term is also for their whole duration.

Therefore from No. 93 we derive the following

Rule

for determining the present value of an assurance on any life or lives.

Add unit to the value of an annuity on the proposed life or lives; multiply the sum by the present value of L.1 *to be received certainly at the end of a year, and from the product subtract the value of an annuity on the same life or lives.*

The remainder will be the value of the assurance in present money.

98. *Example.* Required the present value of L.1 to be received at the end of the year in which the survivor of two lives may fail, their ages now being 40 and 50 years respectively.

The value of an annuity on these lives was shown in No. 66 to be 15·066.

Multiply 16·066 by 0·952381, from the product 15·3009 subtract 15·066, the remainder L.0·2349 is the required value, agreeably to No. 87.

And, in all other cases, the values determined by the rule in the preceding number will be found to agree with those obtained by the method of No. 81.

99. When an assurance on any life or lives has been effected at a constant annual premium, and kept up for some time by the regular payment of that premium, the annual premium required for a new assurance of the same sum on the same life or lives will, on account of the increase of age, be greater than that at which the first assurance was effected: Therefore the present value of all these greater annual premiums, that is, the total present value of the new assurance, will exceed the present value of all the premiums that may hereafter be received under the existing policy. And the excess will evidently be the value of the policy, supposing the life or lives to be still insurable; that being the only advantage which can now be derived from the premiums already paid.

So that if the present value of all the future annual premiums to be paid under an existing policy, for the assurance of a certain sum upon any life or lives, be subtracted from the present value of the assurance of the same sum on the same life or lives, the remainder will be the value of the policy.

100. *Example.* L.1000 has been assured some years on a life now 50 years of age, for its whole duration, at the annual premium of L.20, one of which has just now been paid. What is the value of the policy?

The present value of the assurance of L.1000 on that life has been shown in No. 82 to be L.397. 2s. 10d.; and an annuity on the life being worth 11·66 years' purchase (Table VI.), the present value of all the premiums to be paid in future under the existing policy is 11·66 × L.20 = L.233. 4s.; the value of the policy. therefore, is L.163. 18s. 10d.

Immediately before the payment of the premium the value of the policy would evidently have been less by the premium then due.

101. In our investigations of the values of annuities on lives, we have hitherto assumed that no part of the rent is to be received for the year in which the life wherewith the annuity may terminate fails.

But if a part of the annuity is to be received at the end of that year, proportional to the part of the year which may have elapsed at the time of such failure; as, in a great number of such cases, some of the lives wherewith the annuity terminates will fail in every part of the year, and as many, or very nearly so, in any one part of it as in any other: we may assume that, upon an average, half a year's rent will be received at the end of the year in which such failure happens; and therefore, that by the title to what may be received after the failure of the life or lives whereon the annuity depends, the present value of that annuity will be increased by the present value of the assurance of half a year's rent on the same life or lives.

102. Thus, for example, the present value of the assurance of L.1 on a life of 50 years of age having in No. 82 been shown to be L.0·397143, the value of an annuity of L.1 on that life, when payable till the last moment of its existence, will exceed L.11·66, its value if only payable until the expiration of the last year it survives, by $\left(\frac{\text{L.}0\cdot397143}{2} =\right)$ L.0·199; it will therefore be L.11·859.

103. If at the end of the year in which an assigned life *A* may fail, *Q* or his heirs are to receive L.1, and are at the same time to enter upon an annuity of L.1, to be enjoyed during another life *P*, to be then fixed upon; the present value of *Q's* interest will evidently be the same as that of the assurance on the life of *A*, of a number of pounds, exceeding by unit the number of years' purchase in the value of an annuity on the life of *P*, at the time of nomination.

104. What is the present value of the next presentation to a living of the clear annual value of L.500, *A*, the present incumbent, being now 50 years of age; supposing

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the age of the clerk presented to be 25 at the end of the year in which the present incumbent dies; also, that he takes the whole produce of the living for that year?

By Table VI. it will be found that the value of an annuity of L.1 on a life of 25 is L.15·303; and in No. 82 it has been shown, that the present value of the assurance of L.1 on a life of 50 is L.0·397143. Hence, and by the last number, it appears that if the annual produce of the living were but L.1, the present value of the next presentation would be L.16·303 × 0·397143 = L.6·47467. The required value, therefore, is L.3237. 6s. 9d.

105. If to the value of the succeeding life, determined according to No. 103, the value of the present be added, the sum of these will evidently be the present value of both the lives in succession; and, in the case of the preceding number, will be 6·475 + 11·66 = 18·135 years' purchase.

106. In No. 103 we proceeded upon the supposition that the annuity on the present life is only payable up to the expiration of the last year it survives, and, consequently, that the succeeding life takes the whole rent for the year in which the present fails.

But if the succeeding life is only to take a part of that rent, in the same proportion to the whole as the portion of the year which intervenes between the failure of the present life and the end of the year is to the whole year, then, by reasoning as in No. 101, it will be found that the portion of that rent which the succeeding life will receive may be properly assumed to be one half. And, instead of increasing the number of years' purchase the annuity on the succeeding life will be worth at the end of the year in which the other fails by unit, we must only add one half to that number, in order that the present value of the assurance of the sum on the existing life may be the number of years' purchase which all that may be received during the succeeding life is now worth.

107. The value of the succeeding life, in the case of No. 104, will, upon this hypothesis, be 15·803 × 0·397143 = 6·27605 years' purchase.

And this appears to be the most correct way of calculating the value of an annuity on a succeeding life, although that of No. 103 proceeds upon the principle on which life-interests are generally valued.

108. But the value of two lives in succession will be the same on both hypotheses; the rent for the year in which the first may fail being, in the one case, given entirely to the successor; and, in the other, divided equally between the two.

This is also true of any greater number of successive lives.

PART II.

109. We now proceed to treat the subject of annuities *Algebraically*.

I.—On Annuities-Certain.

Let r denote the *simple interest* of L.1 for one year.
s, any *sum* put out at interest.
n, the *number of years* for which it is lent.
m, its *amount* in that time.
a, an *annuity* for the same time. (3 and 4.)
M, the *amount* to which that *annuity* will increase when each payment is laid up as it becomes due, and improved at compound interest until the end of the term.
V, the *present value* of the same annuity. (6.)

110. Then, reasoning as in the first number of this article, it will be found that $m = s\,(1+r)^n$. And by No. 2 it appears that the present value of s pounds to be received certainly at the expiration of n years, is $s\frac{1}{(1+r)^n}$, or $s\,(1+r)^{-n}$.

111. The amount of L.1 in n years being $(1+r)^n$, its increase in that time will be $(1+r)^n - 1$; and when it is considered that this increase arises entirely from the simple interest (r) of L.1 being laid up at the end of each year, and improved at compound interest during the remainder of the term, it must be obvious that $(1+r)^n - 1$ is the amount of an annuity of r pounds in that time; but $r : a :: (1+r)^n - 1 : \frac{a}{r}\left[(1+r)^n - 1,\right]$ which, therefore, is equal to M, the amount of an annuity of a pounds in n years.

112. Reasoning as in No. 8, it will be found, that since $r : 1 :: a : \frac{a}{r}$, the present value of a perpetual annuity of a pounds is $\frac{a}{r}$.

113. If two persons, A and B, purchase a perpetuity of a pounds between them, which A and his heirs or assigns are to enjoy during the first n years, and B and his heirs or assigns for ever after. Since the value of the perpetuity to be entered upon immediately has just been shown to be $\frac{a}{r}$, the present value of B's share, that is, the present value of the same perpetuity when the entrance thereon is deferred until the expiration n years, will be $\frac{a}{r}(r+1)^{-n}$, (110); and the value of the share of A will be thus much less than that of the whole perpetuity (21), therefore equal to $\frac{a}{r}\left[1 - (1+r)^{-n}\right] = $ V, the present value of an annuity of a pounds for the term of n years certain.

114. If the annuity is not to be entered upon until the expiration of d years, but is then to continue n years, its value at the time of entering upon it will be $\frac{r}{a}\left[1 - (1+r)^{-n}\right]$, as has just been shown; therefore its present value will be

$$\frac{a}{r}\left[(1+r)^{-d} - (1+r)^{-(d+n)}\right] = \text{V}. \quad (110.)$$

115. In the same manner it appears that, when the entrance on a perpetuity of a pounds is deferred d years, its present value will be $\frac{a}{r}(1+r)^{-d}$. (110 and 112.)

116. q being any number whatever, whole, fractional, or mixed, let λq denote its logarithm, and $\varkappa q$ the arithmetical complement of that logarithm; so that these equations may obtain, $\lambda\frac{1}{q} = -\lambda q = \varkappa q$. Then, for the resolution of the principal questions of this kind by logarithms, we shall have these formulæ.

1. *Amount of a sum improved at interest.*

$$\lambda m = n\lambda(1+r) + \lambda s. \quad (110.)$$

2. *Amount of an annuity when each payment is laid up as it becomes due, and improved at interest until the expiration of the term.*

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$$\lambda M = \lambda\left[(1+r)^n - 1\right] + \lambda a + xr. \quad (111.)$$

3. *Value of a lease or an annuity.*

$$\lambda V = \lambda\left[1 - (1+r)^{-n}\right] + \lambda a + xr. \quad (113.)$$

4. *Value of a deferred annuity, or the renewal of any number of years lapsed in the term of a lease.*

$$\lambda V = \lambda\left[(1+r)^{-d} - (1+r)^{-(d+n)}\right] + \lambda a + xr. \quad (114.)$$

5. *Value of a deferred perpetuity, or the reversion of an estate in fee-simple, after an assigned term.*

$$\lambda V = \lambda a + xr + dx(1+r). \quad (115.)$$

By means of each of these equations, it is manifest that any one of the quantities involved in it may be found when the rest are given.

117. If the interest be convertible into principal ν times in the year, at ν equal intervals; since the interest of L.1 for one of these intervals will be $\frac{r}{\nu}$ (109), and the number of conversions of interest into principal in n years νn; to adapt the formula in No. 110 to this case, we have only to substitute $\frac{r}{\nu}$ for r, and νn for n, in the equation $m = s(1+r)^n$ there given, whereby it will be transformed to this, $m = s\left(1+\frac{r}{\nu}\right)^{\nu n}$.

118. According as ν is equal to 1, 2, 4, or is infinite, that is, according as the interest is convertible into principal yearly, half-yearly, quarterly, or continually, let m be equal to Y, H, Q, or C; so shall

$$\text{Y} = s(1+r)^n,$$

$$\text{H} = s\left(1+\frac{r}{2}\right)^{2n},$$

$$\text{Q} = s\left(1+\frac{r}{4}\right)^{4n},$$

$$\text{and C} = s \cdot \text{N};$$

N being the number of which nr is the hyperbolic logarithm, and $nr \times 0{\cdot}43429448$ its logarithm in Briggs' *System*, and the common tables.

119. From No. 117 and 110, it follows that the present value of s pounds to be received at the end of n years, when the interest is convertible into principal at ν equal intervals in each year, is $s\left(1+\frac{r}{\nu}\right)^{-\nu n}$.

120. When the present values and the amounts of annuities are desired, let the interest be convertible into principal at ν equal intervals in the year, while the annuity is payable at π intervals therein, the amount of each payment being $\frac{a}{\pi}$.

121. *Case* 1. μ being any whole number not greater than ν, let $\frac{1}{\pi} = \frac{\mu}{\nu}$, so that the interest may be convertible into principal μ times in each of the intervals between the payments of the annuity.

Then will the amount of L.1 at the expiration of the period $\frac{1}{\pi}$ be $\left(1+\frac{r}{\nu}\right)^{\mu}$ (117), and the interest of L.1 for the same time will be $\left(1+\frac{r}{\nu}\right)^{\mu} - 1$; whence the present value of the perpetuity will be $\dfrac{\frac{1}{\pi}a}{\left(1+\frac{r}{\nu}\right)^{\mu}-1}$ (8), and the value of the same deferred n years, will be $\frac{a}{\pi} \cdot \dfrac{\left(1+\frac{r}{\nu}\right)^{-\nu n}}{\left(1+\frac{r}{\nu}\right)^{\mu}-1}$ (119), therefore the present value of the annuity to be entered upon immediately, and to continue n years, will be

$$\frac{a}{\pi} \cdot \frac{1-\left(1+\frac{r}{\nu}\right)^{-\nu n}}{\left(1+\frac{r}{\nu}\right)^{\mu}-1} = \text{V}.$$

122. *Case* 2. μ being any whole number greater than π, let $\frac{1}{\nu} = \frac{\mu}{\pi}$, so that the annuity may be payable μ times in each of the intervals between the payments of interest, or the conversion thereof into principal.

Then, at the expiration of the $\frac{1}{\nu}$th of a year, when the interest on the purchase-money is first payable or controvertible, the interest on all the $\mu - 1$ payments of the annuity previously made will be

$$\frac{ar}{\pi\pi}\left[(\mu-1)+(\mu-2)+(\mu-3)+\ldots\ldots+3+2+1\right]$$

$= \frac{a}{\pi} \cdot \frac{r\mu(\mu-1)}{2\pi}$; to which adding the μ payments of $\frac{a}{\pi}$ each (including the one only then due), the sum $\frac{a}{\pi}\left[\mu + \frac{r\mu(\mu-1)}{2\pi}\right]$, is the simple interest which the value of the perpetuity should yield at the expiration of each νth part of a year, in order to supply the deficiency (both of principal and interest) that would be occasioned during each of those periods, in any fund out of which the several payments of the annuity might be taken, as they respectively became due; and since $\frac{r}{\nu} : \frac{a}{\pi}\left[\mu + \frac{r\mu(\mu-1)}{2\pi}\right]$ $:: 1 : \frac{a\nu}{r\pi}\left[\mu + \frac{r\mu(\mu-1)}{2\pi}\right] = a\left(\frac{1}{r} + \frac{\mu-1}{2\pi}\right)$, this last expression will be the value of such perpetuity with immediate possession (8); the value of the same deferred n years will therefore be $a\left(\frac{1}{r}+\frac{\mu-1}{2\pi}\right) \times \left(1+\frac{r}{\nu}\right)^{-\nu n}$ (119). Whence it appears that the present value of the annuity to be entered upon immediately, and to continue n years, will be $a\left(\frac{1}{r}+\frac{\mu-1}{2\pi}\right) \cdot \left[1-\left(1+\frac{r}{\nu}\right)^{-\nu n}\right] = \text{V}.$

123. *Case* 3. When, in consequence of the annuity being always payable at the same time that the interest is convertible, $\nu = \pi$.

Since the interest of L.1 at the expiration of the period $\frac{1}{\pi}$ will be $\frac{r}{\pi}$, the value of the perpetuity will be $\dfrac{\frac{1}{\pi}a}{\frac{1}{\pi}r} = \frac{a}{r}$ (8), whence, proceeding as before, we obtain the present value of the annuity, $\frac{a}{r}\left[1-\left(1+\frac{r}{\nu}\right)^{-\nu n}\right] = \text{V}.$ Whence $\nu = \pi$, and consequently $\mu = 1$, the values of V given in the two preceding cases, will be found to coincide with this.

124. According as ν and π are each equal to 1, 2, 4, or are infinite; that is, according as the interest and the annuity are each payable yearly, half-yearly, quarterly, or continually, let V be equal to y, h, q, or c, then will

$$y = \frac{a}{r}\left[1-(1+r)^{-n}\right],$$

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$$h=\frac{a}{r}\left[1-\left(1+\frac{r}{2}\right)^{-2n}\right]$$

$$q=\frac{a}{r}\left[1-\left(1+\frac{r}{4}\right)^{-4n}\right],$$

and $c=\frac{a}{r}\left[1-\frac{1}{\text{N}}\right]$, N being as in No. 118.

125. The amount of an annuity is equal to the sum to which the purchase-money would amount if it were put out and improved at interest during the whole term.

For, from the time of the purchase of the annuity, whatever part of the money that was paid for it may be in the hands of the granter, he must improve thus to provide for the payments thereof; and if the purchaser also improve in the same manner all he receives, the original purchase-money must evidently receive the same improvement during the term, as if it had been laid up at interest at its commencement.

126. The periods of conversion of interest into principal, and of the payment of the annuity being still designated as in No. 120; since in n years the number of periods of conversion will be m, in the

1*st Case*, where the interest is convertible μ times in each of the intervals between the payments of the annuity, we have $\left(1+\frac{r}{\nu}\right)^{m}\text{V}=\frac{a}{\pi}\cdot\frac{\left(1+\frac{r}{\nu}\right)^{m}-1}{\left(1+\frac{r}{\nu}\right)^{\mu}-1}=\text{M}$. (117, 121, and 125.) In the 2*d Case*, when the annuity is payable μ times, in each interval between the conversions of interest,

$$\left(1+\frac{r}{\nu}\right)^{m}\text{V}=a\left[\frac{1}{r}+\frac{\mu-1}{2\pi}\right]\cdot\left[\left(1+\frac{r}{\nu}\right)^{m}-1\right]$$

$=\text{M}$. (117, 122, and 125.)

And, in the 3*d Case*, when the annuity is always payable at the same time that the interest is convertible, $\left(1+\frac{r}{\nu}\right)^{m}\text{V}=\frac{a}{r}\left[\left(1+\frac{r}{\nu}\right)^{m}-1\right]=\text{M}$.(117, 123, and 125.)

127. According as ν and π are each equal to 1, 2, 4, or are infinite; that is, according as the interest and the annuity are each payable yearly, half-yearly, quarterly, or continually, let M be denoted by y', h', q', or c';

then will
$$y'=\frac{a}{r}\left[(1+r)^{n}-1\right],$$

$$h'=\frac{a}{r}\left[\left(1+\frac{r}{2}\right)^{2n}-1\right],$$

$$q'=\frac{a}{r}\left[\left(1+\frac{r}{4}\right)^{4n}-1\right],$$

and $c=\frac{a}{r}(\text{N}-1)$; N being as in No. 118.

128. *Example* 1. What will L.320 amount to, when improved at compound interest during 40 years, the rate of interest being 4 *per cent. per annum?*

By the first formula in No. 116, the operation will be as follows:

$$\begin{aligned} 1\times r &= 1{\cdot}04\ \lambda\ 0{\cdot}01703334\\ &\qquad +n=40\\ (1+r)^{n}&\ \lambda\ 0{\cdot}6813336\\ s&=320\ \lambda\ 2{\cdot}5051500\\ m&=1536{\cdot}327\ \lambda\ 3.1864836 \end{aligned}$$

And the answer is L.1536. 6s. 6½d.

129. *Ex.* 2. If the interest were convertible into principal every half-year, the operation, according to No. 117, would be thus:

$$\begin{aligned} 1+\frac{r}{2}&=1{\cdot}02\ \lambda\ 0{\cdot}00860017\\ &\qquad\times m=80\\ &\qquad 0{\cdot}6880136\\ s&=320\ \lambda\ 2{\cdot}5051500\\ m&=1560{\cdot}14\ \lambda\ 3{\cdot}1931636 \end{aligned}$$

So that in this case the amount would be L.1560. 2s. 9½d.

130. *Ex.* 3. Required the present value of an annuity of L.250 for 30 years, reckoning interest at 5 *per cent.*

By the third formula in No. 116, the operation will be thus:

$$\begin{aligned} \lambda(1+r)^{-1}&=\varkappa\ 1{\cdot}05=\bar{1}{\cdot}9788107\\ &\qquad\times n=30\\ (1+r)^{-n}&=\cdot23137704\ \lambda\ \bar{1}{\cdot}3643210\\ 1-(1+r)^{-n}&=\cdot76862296\ \lambda\ \bar{1}{\cdot}8857133\\ a&=250\ \lambda\ 2{\cdot}3979400\\ r&=\cdot05\ \varkappa\ 1{\cdot}3010300\\ \text{V}&=3843{\cdot}114\ \lambda\ 3{\cdot}5846833 \end{aligned}$$

And the required value is L.3843. 2s. 3¼d.

131. *Ex.* 4. The rest being still the same, if the annuity in the last example be payable half-yearly, in the formula of No. 122 ν will be equal to 1, $\pi=2$, and $\mu=2$; that formula will therefore become $a\left(\frac{1}{r}+\frac{1}{4}\right)\cdot\left[1-(1+r)^{-n}\right]$ $=\text{V}$; and the operation will be thus:

$$\left.\begin{aligned} 1-(1+r)^{-n}&\ \lambda\ \bar{1}{\cdot}8857133\\ a&=250\ \lambda\ 2{\cdot}3979400 \end{aligned}\right\}\ \text{No. 130.}$$

$$\begin{aligned} \frac{1}{r}+\frac{1}{4}&=20{\cdot}25\ \lambda\ 1{\cdot}3064250\\ \text{V}&=3891{\cdot}15\ \lambda\ 3{\cdot}5900783 \end{aligned}$$

The value of the annuity will therefore in this case be L.3891. 3s.

132. *Ex.* 5. To what sum will an annuity of L.120 for 20 years amount, when each payment is improved at compound interest from the time of its becoming due until the expiration of the term, the rate of interest being 6 *per cent.?*

The operation by the second formula in No. 116 is thus:

$$\begin{aligned} 1+r&=1{\cdot}06\ \lambda\ 0{\cdot}025305865\\ &\qquad\times n=20\\ (1+r)^{n}&=3{\cdot}207135\ \lambda\ 0{\cdot}5061173\\ (1+r)^{n}-1&=2{\cdot}207135\ \lambda\ 0{\cdot}3438289\\ a&=120\ \lambda\ 2{\cdot}0791812\\ r&=\cdot06\ \varkappa\ 1{\cdot}2218487\\ \text{M}&=4414{\cdot}27\ \lambda\ 3{\cdot}6448588 \end{aligned}$$

And the amount required is L.4414. 5s. 5d.

133. *Ex.* 6. The rest being the same as in the last example; if both the interest and the annuity be payable half-yearly, the amount will be determined by the second of the formulæ given in No. 127, which in this case will become $\frac{120}{\cdot06}\left[(1{\cdot}03)^{40}-1\right]$, and the operation will be as follows:

$$\begin{aligned} 1{\cdot}03&\ \lambda\ 0{\cdot}01283723\\ &\qquad\times 40\\ (1{\cdot}03)^{40}&=3{\cdot}26204\ \lambda\ 0{\cdot}5134892\\ (1{\cdot}03)^{40}-1&=2{\cdot}26204\ \lambda\ 0{\cdot}3545003\\ &\qquad\lambda\ 2{\cdot}0791812\\ &\cdot06\ \varkappa\ 1{\cdot}2218487\\ \text{M}&=4524{\cdot}08\ \lambda\ 3{\cdot}6555302 \end{aligned}$$

So that the amount in this case would be L.4524. 1s. 7¼d.

Algebraical View.

II.—On the Probabilities of Life.

134. Any persons, A, B, C, &c. being proposed, let the numbers which tables of mortality (32) adapted to them represent to attain to their respective ages be denoted by the symbols a, b, c, &c.; while lives n years older than those respectively are denoted thus, ^{n}A, ^{n}B, ^{n}C, &c. and the numbers that attain to their ages, by the symbols ^{n}a, ^{n}b, ^{n}c, &c.; also let lives n years younger than A, B, C, &c. be denoted thus, A_n, B_n, C_n, &c., while the numbers which the tables show to attain to those younger ages are designated by the symbols a_n, b_n, c_n, &c.

Then, if A be 21 years of age, and we use the Carlisle table, we shall have $a = 6047$, and $^{14}a = 5362$, the number that attain to the age of 35, or that live to be 14 years older than A.

Hence the number that are represented by the table to die in n years from the age of A will be $a - {}^{n}a$, that is, in 14 years, $a - {}^{14}a$; and, by the Carlisle table, in 14 years from the age of 21, that is, between 21 and 35, it will be $6047 - 5362 = 685$.

135. *Problem.* To determine the probability that a proposed life A will survive n years.

Solution. a being the number of lives in the table of mortality attaining the age of that which is proposed, conceive that number of lives to be so selected (of which A must be one), that they may each have the same prospect with regard to longevity as the proposed life and those in the table, or the average of those from which it was constructed; then will the number of them that survive the term be ^{n}a. (134.)

So that the number of ways all equally probable, or the number of equal chances for the happening of the event in question, is ^{n}a; and the whole number for its either happening or failing is a; therefore, according to the first principles of the doctrine of probabilities, the probability of the event happening, that is, of A surviving the term, is $\frac{^{n}a}{a}$.

If the age of A be 14, the probability of that life surviving 7 years, or the age of 21, will, according to the Carlisle table, be $\frac{^{7}a}{a} = \frac{6047}{6335}$, or 0·95454.

136. Since the number that die in n years from the age of A is $a - {}^{n}a$ (134), it appears, in the same manner, that the probability of that life failing in n years will be $\frac{a - {}^{n}a}{a} = 1 - \frac{^{n}a}{a}$; which probability, when the life, term, and table of mortality are the same as in the last No., will be 0·04546.

137. If two lives A and B be proposed, since the probability of A surviving n years will be $\frac{^{n}a}{a}$, and that of B surviving the same term will be $\frac{^{n}b}{b}$, it appears from the doctrine of probabilities that $\frac{^{n}a}{a} \cdot \frac{^{n}b}{b}$ or $\frac{^{n}(ab)}{ab}$ will be the measure of the probability that these lives will both survive n years.

In the same manner it may be shown, that the probability of the three lives A, B, and C all surviving n years, will be measured by $\frac{^{n}a}{a} \cdot \frac{^{n}b}{b} \cdot \frac{^{n}c}{c}$, or $\frac{^{n}(abc)}{abc}$. And, universally, that any number of lives A, B, C, &c. will jointly survive n years, the probability is $\frac{^{n}(abc, \text{\&c.})}{abc, \text{\&c.}}$

138. Let $\frac{^{n}a}{a} = {}_{n}a$, $\frac{^{n}b}{b} = {}_{n}b$, $\frac{^{n}c}{c} = {}_{n}c$, &c.; also let $\frac{^{n}(abc, \text{\&c.})}{abc, \text{\&c.}} = {}_{n}(abc, \text{\&c.})$; so that the probabilities of A, B, C, &c. surviving n years may be denoted by ${}_{n}a$, ${}_{n}b$, ${}_{n}c$, &c. respectively; and that of all these lives jointly surviving that term by ${}_{n}(abc, \text{\&c.})$

Algebraical View.

Then will the probability that none of these lives will survive n years be $(1 - {}_{n}a) \cdot (1 - {}_{n}b) \cdot (1 - {}_{n}c) \cdot \text{\&c.}$

139. But the probability that some one or more of these lives will survive n years will be just what the probability last mentioned is deficient of certainty: its measure, therefore, being just what the measure of that probability is deficient of unit, will be

$$1 - (1 - {}_{n}a) \cdot (1 - {}_{n}b) \cdot (1 - {}_{n}c) \cdot \text{\&c.}$$

140. *Corol.* 1. When there is only one life A, this will be ${}_{n}a$.

141. *Corol.* 2. When there are two lives A and B, it becomes ${}_{n}a + {}_{n}b - {}_{n}(ab)$.

142. *Corol.* 3. When there are three lives A, B, and C, it becomes ${}_{n}a + {}_{n}b + {}_{n}c - {}_{n}(ab) - {}_{n}(ac) - {}_{n}(bc) + {}_{n}(abc)$.

143. When three lives A, B, and C are proposed, that at the expiration of n years there will be

living	dead	the probability is
ABC	none	.... $+ {}_{n}(abc)$
AB	C	${}_{n}(ab) \cdot (1 - {}_{n}c) = {}_{n}(ab) - {}_{n}(abc)$
AC	B	${}_{n}(ac) \cdot (1 - {}_{n}b) = {}_{n}(ac) - {}_{n}(abc)$
BC	A	${}_{n}(bc) \cdot (1 - {}_{n}a) = {}_{n}(bc) - {}_{n}(abc)$

And the sum of these four ${}_{n}(ab) + {}_{n}(ac) + {}_{n}(bc) - 2{}_{n}(abc)$, is the measure of the probability that some two at the least out of these three lives will survive the term.

III.—Of Annuities on Lives.

144. Let the number of years' purchase that an annuity on the life of A is worth, that is, the present value of L.1 to be received at the end of every year during the continuance of that life, be denoted by A; while the present value of an annuity on any number of joint lives A, B, C, &c. that is, of an annuity which is to continue during the joint existence of all the lives, but to cease with the first that fails, is denoted by ABC, &c.

Then will the value of an annuity on the joint continuance of the three lives A, B, and C, be denoted by ABC.

And on the joint continuance of the two A and B, by AB.

145. Also let ^{t}A and A$_{t}$ denote the values of annuities on lives respectively older and younger than A, by t years; while ^{t}(ABC, &c.) designates the value of an annuity on the joint continuance of lives t years older than A, B, C, &c. respectively; and (ABC, &c.)$_{t}$ that of an annuity on the same number of joint lives, as many years younger than these respectively.

146. Let $\frac{1}{1+r}$, the present value of L.1 to be received certainly at the expiration of a year, be denoted by v.

Then will v^n be the present value of that sum certain to be received at the expiration of n years.

But if its receipt at the end of that time be dependent upon an assigned life A surviving the term, its present value will, by that condition, be reduced in the ratio of certainty to the probability of A surviving the term, that is, in the ratio of unit to ${}_{n}a$, and will therefore be ${}_{n}av^n$.

In the same manner it appears, that if the receipt of the money at the expiration of the term be dependent upon any assigned lives, as A, B, C, &c. jointly surviving that period, its present value will be ${}_{n}(abc, \text{\&c.})v^n$.

Algebraical View.

147. Let us denote the sum of any series, as ${}_1(abc)v + {}_2(abc)v^2 + {}_3(abc)v^3 +$ &c. thus, $S_n(abc)v^n$, by prefixing the Italic capital S to the general term thereof. Then, from what has just been advanced, it will be evident that ABC, &c. $= S_n(abc, \&c.)v^n$.

When there are but three lives, A, B, and C, this becomes ABC $= S_n(abc)v^n$.

When there are but two, A and B, it becomes AB $= S_n(ab)v^n$.

And in the same manner it appears, that for a single life A, A $= S_n av^n$.

148. ${}_n(abc, \&c.)v^n = \dfrac{{}^n(abc, \&c.)v^n}{abc, \&c.}$ (138), where the denominator (abc, &c.) is constant, while the numerator varies with the variable exponent n. And the most obvious method of finding the value of an annuity on any assigned single or joint lives, is to calculate the numerical value of the term ${}^n(abc, \&c.)v^n$ for each value of n, and then to divide the sum of all these values by abc, &c.; for $\dfrac{S^n(abc, \&c.)v^n}{abc, \&c.} = S_n(abc, \&c.)v^n =$ ABC, &c.

In calculating a table of the values of annuities on lives in that manner, for every combination of joint lives it would be necessary to calculate the term ${}^n(abc, \&c.)v^n$ for as many years as there might be between the age of the oldest life involved and the oldest in the table; and the same number of the terms ${}^nav^n$ for any single life of the same age.

But this labour may be greatly abridged as follows:

PROB. I.

149. Given ${}'$(ABC, &c.), the value of an annuity on any number of joint lives, to determine ABC, &c. that of an annuity on the same number of joint lives respectively one year younger than they.

Solution.

If it were certain that the lives ABC, &c. would all survive one year, the proprietor of an annuity of L.1 dependent upon their joint continuance would, at the expiration of a year, be in possession of L.1 (the first year's rent), and an annuity on the same number of lives one year older respectively than ABC, &c.; therefore, in that case, the required present value of the annuity would be $v[1 + {}'$(ABC, &c.)$]$. (146.)

But the probability of the lives A, B, C, &c. jointly surviving one year is less than certainty in the ratio of ${}_{\prime}(abc$, &c.) to unit; therefore ABC, &c. $= {}_{\prime}(abc$, &c.) $v[1 + {}'$(ABC, &c.)$]$.

150. *Corol.* 1. When there are but three lives, A, B, and C, this becomes ABC $= {}_{\prime}(abc)v[1 + {}'(ABC)]$.

151. *Corol.* 2. When there are only two, A and B, AB $= {}_{\prime}(ab)v[1 + {}'(AB)]$.

152. *Corol.* 3. And for a single life A, it appears, in the same manner, that A $= {}_{\prime}av(1 + {}'$A).

153. Hence, in logarithms, we have these equations,

$$\lambda \text{A} = \lambda v + \lambda {}_{\prime}a + \lambda(1 + {}'\text{A}),$$
$$\lambda \text{AB} = \lambda v + \lambda {}_{\prime}a + \lambda {}_{\prime}b + \lambda[1 + {}'(\text{AB})],$$
$$\lambda \text{ABC} = \lambda v + \lambda {}_{\prime}a + \lambda {}_{\prime}b + \lambda {}_{\prime}c + \lambda[1 + {}'(\text{ABC})],$$
&c. &c. &c.

Upon which it may be observed, that $\lambda v + \lambda {}_{\prime}a$, the sum of the first two logarithms that are employed in determining A from ${}'$A, also enters the operation whereby AB is determined from ${}'$(AB). And that $\lambda v + \lambda {}_{\prime}a + \lambda {}_{\prime}b$, the sum of the first three logarithms that serve to determine AB from ${}'$(AB), is also required to determine ABC from ${}'$(ABC); which observation may be extended in a similar manner to any greater number of joint lives.

154. By these means it is easy to complete a table of the values of annuities on single lives of all ages, beginning with the oldest in the table, and proceeding regularly age by age to the youngest.

Algebraical View.

Also a table of the values of any number of joint lives, the lives in each succeeding combination, in any one series of operations (according to the retrograde order of the ages in which they are computed), being one year younger respectively than those in the preceding combination.

And, if a table of single lives be computed first, then of two joint lives, next of three joint lives, and so on, the calculations made for the preceding tables will be of great use for the succeeding.

155. Having shown how to compute tables of the values of annuities on single and joint lives, we shall, in what follows, always suppose those values to be given.

156. Let the value of an annuity on the joint continuance of any number of lives, A, B, C, &c. that is not to be entered upon until the expiration of t years, be denoted by $\neg^t$(ABC, &c.).

Then, if it were certain that all the lives would survive the term, since the value of the annuity at the expiration of the term would be ^{t}(ABC, &c.) (145), its present value would be $v^t . {}^t$(ABC, &c.) (146).

But the measure of the probability that all the lives will survive the term is ${}_t(abc$, &c.), therefore $\neg^t$(ABC, &c.) $= {}_t(abc$, &c.) $v^t . {}^t$(ABC, &c.).

In the same manner, it appears, that for a single life A, $\neg^t$A $= {}_tav^t . {}^t$A.

157. Let an annuity for the term of t years only, dependent upon the joint continuance of any number of lives, A, B, C, &c. be denoted by $\underset{t|}{-}$(ABC, &c.); and, since this *temporary* annuity, together with an annuity on the joint continuance of the same lives *deferred* for the same term, will evidently be of the same value as an annuity to be entered upon immediately, and enjoyed during their whole joint continuance, we have $\underset{t|}{-}$(ABC, &c.) $+ \neg^t$ (ABC, &c.) $=$ ABC, &c.; whence, $\underset{t|}{-}$(ABC, &c.) $=$ ABC, &c. $- \neg$ (ABC, &c.).

And for a single life A, $\underset{t|}{-}$A $=$ A $- \neg^t$A.

PROB. II.

158. To determine the present value of an annuity on the survivor of the two lives A and B (155); which we designate thus, $\overline{\text{AB}}$.

Solution.

The probability that the survivor of these two lives will outlive the term of n years was shown in No. 141 to be ${}_na + {}_nb - {}_n(ab)$; therefore, reasoning as in No. 146, it will be found that the present value of the nth year's rent of this annuity is $[{}_na + b - {}_n(ab)]v^n$, and the value of all the rents thereof will be $S[{}_na + {}_nb - {}_n(ab)]v^n$, or $S_nav^n + S_nbv^n - S_n(ab)\ v^n$; so that $\overline{\text{AB}} =$ A $+$ B $-$ AB (147), agreeably to No. 48.

PROB. III.

159. To determine the present value of an annuity on the last survivor of three lives, A, B, and C (155); which we denote thus, $\overline{\text{ABC}}$.

Solution.

The present value of the nth year's rent is $[{}_na + {}_nb + {}_nc - {}_n(ab) - {}_n(ac) - {}_n(bc) + {}_n(abc)]v^n$ (142 and 146); whence, it appears, as in the preceding number, that $\overline{\text{ABC}} =$ A $+$ B $+$ C $-$ AB $-$ AC $-$ BC $+$ ABC, agreeably to No. 52.

Algebraical View.

PROB. IV.

160. To determine the present value of an annuity on the joint existence of the last two survivors out of three lives, A, B, C, (155); which we denote thus, $\overset{2}{\overline{\text{ABC}}}$.

Solution.

The present value of the nth year's rent is $[_n(ab) + {_n(ac)} + {_n(bc)} - 2_n(abc)]v^n$ (143 and 146); whence, reasoning as in the two preceding numbers, we infer, that $\overset{2}{\overline{\text{ABC}}} = \text{AB} + \text{AC} + \text{BC} - 2\ \text{ABC}$, as was demonstrated otherwise in No. 51.

161. Since the solutions of the last three problems were all obtained by showing each year's rent (as for instance the nth) of the annuity in question to be of the same value with the aggregate of the rents for the same year of all the annuities (taken with their proper signs) on the single and joint lives exhibited in the resulting formula; if any term of years be assigned, it is manifest that the value of such annuity for the term must be the same as that of the aggregate of the annuities above mentioned, each for the same term.

PROB. V.

162. A and B being any two proposed lives now both existing, to determine the present value of an annuity receivable only while A survives B.

Solution.

A rent of this annuity will only be payable at the end of the nth year, provided that B be then dead and A living; but the probability of B being then dead is $1 - {_nb}$, and that of A being then living $_na$, and these two events are independent; therefore, the probability of their both happening, or that of the rent being received, is $(1 - {_nb})\,{_na} = {_na} - {_n(ab)}$; the present value of that rent is, therefore, $[_na - {_n(ab)}]v^n$; whence it follows, that the required value of the annuity on the life of A after that of B is $\text{A} - \text{AB}$, agreeably to No. 60.

163. If the payment for the annuity which was the subject of the last problem is not to be made in present money, but by a constant annual premium p at the end of each year, while both the lives survive; since AB is the number of years' purchase (6) that an annuity on the joint continuance of those lives is worth, the value of p will be determined by this equation, $\text{p} \cdot \text{AB} = \text{A} - \text{AB}$, whence we have $\text{p} = \frac{\text{A}}{\text{AB}} - 1$.

164. But if one premium p is to be paid down now, and an equal premium at the end of each year while both the lives survive, we shall have $p \cdot (1 + \text{AB}) = \text{A} - \text{AB}$, and $p = \frac{\text{A} - \text{AB}}{1 + \text{AB}}$.

165. For numerical examples illustrative of the formulæ given from No. 158 to the present, see Nos. 66–74.

PROB. VI.

166. A and B are in possession of an annuity on the life of the survivor of them, which, if either of them die before a third person C, is then to be divided equally between C and the survivor during their joint lives; to determine the value of C's interest.

Solution.

That at the end of the nth year there will be dead	living	the probability, multiplied by C's proportion of the annuity in that circumstance, is
A	BC	$\frac{1}{2}(1 - {_na}) \cdot {_n(bc)} = \frac{1}{2}[_n(bc) - {_n(abc)}]$
B	AC	$\frac{1}{2}(1 - {_nb}) \cdot {_n(ac)} = \frac{1}{2}[_n(ac) - {_n(abc)}]$;

and the sum of these being $\frac{1}{2}{_n(ac)} + \frac{1}{2}{_n(bc)} - {_n(abc)}$, the value of C's interest is $\frac{1}{2}\,\text{AC} + \frac{1}{2}\,\text{BC} - \text{ABC}$.

Algebraical View.

PROB. VII.

167. An annuity, after the decease of A, is to be equally divided between B and C during their joint lives, and is then to go entirely to the last survivor for his life; it is proposed to find the value of B's interest therein.

Solution.

That at the end of the nth year there will be dead	living	the probability, multiplied by B's proportion of the annuity in that circumstance, is
A	BC	...........$+ \frac{1}{2}{_n(bc)} - \frac{1}{2}{_n(abc)}$
AC	B	${_nb} - {_n(ab)} - {_n(bc)} + {_n(abc)}$; and the sum

of these being ${_nb} - {_n(ab)} - \frac{1}{2}{_n(bc)} + \frac{1}{2}{_n(abc)}$, the value of B's interest is $\text{B} - \text{AB} - \frac{1}{2}\,\text{BC} + \frac{1}{2}\,\text{ABC}$.

PROB. VIII.

168. A, B, and C purchase an annuity on the life of the last survivor of them, which is to be divided equally at the end of every year among such of them as may then be living; what should A contribute towards the purchase of this annuity?

Solution.

That at the end of n years there will be dead	living	the probability, multiplied by A's proportion of the annuity in that circumstance, is
none	ABC	....................$+ \frac{1}{3}{_n(abc)}$
C	AB	....$+ \frac{1}{2}{_n(ab)}$......$- \frac{1}{2}{_n(abc)}$
B	AC	.........$+ \frac{1}{2}{_n(ac)} - \frac{1}{2}{_n(abc)}$
BC	A	${_na} - {_n(ab)} - {_n(ac)} + {_n(abc)}$; and the sum

of these being ${_na} - \frac{1}{2}{_n(ab)} - \frac{1}{2}{_n(ac)} + \frac{1}{3}{_n(abc)}$, the required value of A's interest is $\text{A} - \frac{1}{2}\,\text{AB} - \frac{1}{2}\,\text{AC} + \frac{1}{3}\,\text{ABC}$.

PROB. IX.

169. As soon as any two of the three lives, A, B, and C, are extinct, D or his heirs are to enter upon an annuity, which they are to enjoy during the remainder of the survivor's life; to determine the value of D's interest therein.

Solution.

That at the end of n years there will be dead	living	The probability is
AB	C	${_nc} - {_n(ac)} - {_n(bc)} + {_n(abc)}$
AC	B	${_nb} - {_n(ab)} - {_n(bc)} + {_n(abc)}$
BC	A	${_na} - {_n(ab)} - {_n(ac)} + {_n(abc)}$; and the sum

of all these being ${_na} + {_nb} + {_nc} - 2_n(ab) - 2_n(ac) - 2_n(bc) + 3_n(abc)$, the value of D's interest is

$$\text{A} + \text{B} + \text{C} - 2\ \text{AB} - 2\ \text{AC} - 2\ \text{BC} + 3\ \text{ABC}.$$

170. The last four may be sufficient to show the method of proceeding with any similar problems.

171. Let ${_t}\left(\overset{m}{\overline{abc,\ \&c.}}\right)$ denote the probability that the last m survivors out of $m + \mu$ lives A, B, C, &c. will jointly survive the term of t years. And when $\mu = 0$, the expression will become ${_t}(abc,\ \&c.)$, the probability that the lives will all survive the term. (138.)

When $m = 1$ it will become ${_t}\left(\overset{1}{\overline{abc,\ \&c.}}\right)$, the measure of

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the probability that the last survivor of them will outlive the term, which it will be better to write thus, ${}_t(\overline{abc, \&c.})$, retaining the vinculum, but omitting the unit over it, as in the notation of powers.

Also let $\overline{\overset{m}{\text{ABC, \&c.}}}$ denote the value of an annuity on the joint continuance of the same number of last survivors out of the same lives. Then, if μ be equal to 0, it will be ABC, &c. the value of an annuity on the joint continuance of all the lives; when $m=1$, it will be $\overline{\text{ABC, \&c.}}$ the value of an annuity on the last survivor of them. The values of annuities on the last survivor of two and of three lives will be denoted as in Nos. 158 and 159 respectively; and that of an annuity on the joint continuance of the last two survivors out of three lives, as in No. 160.

The value of an annuity on the last m survivors out of these $m+\mu$ lives, according as it is limited to the term of t years, or deferred during that term, will also be denoted by $\underset{t|}{}\overline{\overset{m}{\text{ABC, \&c.}}}$ or $\underset{|}{}{}_t\overline{\overset{m}{\text{ABC, \&c.}}}$ (156 and 157.)

PROB. X.

172. An annuity certain for the term of $t+\nu$ years is to be enjoyed by P and his heirs during the joint existence of the last m survivors out of $m+\mu$ lives, A, B, C, &c.; and if that joint existence fail before the expiration of t years, the annuity is to go to Q and his heirs for the remainder of the term; to determine the value of Q's interest in that annuity.

Solution.

Q's expectation may be distinguished into two parts:

1*st*, That of enjoying the annuity during the term of t years.

2*d*, That of enjoying it after the expiration of that term.

The sum of the present values of the interests of P and Q together in the annuity for the term of t years, is manifestly equal to the whole present value of the annuity certain for that term; that is, equal to $\frac{1-v^t}{r}$ (113 and 146); and the value of P's interest for the term of t years is $\underset{t|}{}\overline{\overset{m}{\text{ABC, \&c.}}}$ (171); therefore the value of Q's interest for the same term is $\frac{1-v^t}{r} - \underset{t|}{}\overline{\overset{m}{\text{ABC, \&c.}}}$

The present value of the annuity certain for ν years after t years is $\frac{v^t(1-v^\nu)}{r}$ (114 and 146); and Q and his heirs will receive this annuity if the joint continuance of the last m survivors above mentioned fail before the expiration of t years; but the probability of their joint continuance failing in the term is $1-{}_t\left(\overline{\overset{m}{abc, \&c.}}\right)$; therefore the value of Q's interest in the annuity to be received after t years, is $\left[1-{}_t\left(\overline{\overset{m}{abc, \&c.}}\right)\right]\frac{v^t(1-v^\nu)}{r}$; and the whole value of Q's interest is

$$\frac{1}{r}\left[1-v^{\nu+t}-v^t(1-v^\nu)\cdot{}_t\left(\overline{\overset{m}{abc, \&c.}}\right)\right] - \underset{t|}{}\overline{\overset{m}{\text{ABC, \&c.}}}$$

173. *Corol.* 1. When the whole annuity certain is a perpetuity, $v^{t+\nu}=0$, and the value of Q's interest is

$$\frac{1}{r}\left[1-{}_t\left(\overline{\overset{m}{abc, \&c.}}\right)v^t\right] - \underset{t|}{}\overline{\overset{m}{\text{ABC, \&c}}}$$

174. *Corol.* 2 When the term t is not less than the greatest joint continuance of any m of the proposed lives, according to the tables of mortality adapted to them, ${}_t\left(\overline{\overset{m}{abc, \&c.}}\right)=0$, and $\underset{t|}{}\overline{\overset{m}{\text{ABC, \&c.}}} = \overline{\overset{m}{\text{ABC, \&c.}}}$; therefore, in that case, the general formula of No. 172 becomes $\frac{1-v^{\nu+t}}{r} - \overline{\overset{m}{\text{ABC, \&c.}}}$; that is, the excess of the value of an annuity certain for the whole term $\nu+t$, above that of an annuity on the whole duration of joint continuance of the last m surviving lives.

175. And if, in the case proposed in the last No., the annuity certain be a perpetuity, as in No. 173, the formula will become $\frac{1}{r} - \overline{\overset{m}{\text{ABC, \&c.}}}$ the excess of the value of the perpetuity above the value of an annuity on the joint lives of the last m survivors; agreeably to No. 63.

176. *Example* 1. Required the present value of the absolute reversion of an estate in fee simple, after the extinction of the last survivor of three lives, A, B, C, now aged 50, 55, and 60 years respectively; reckoning interest at 5 *per cent.*

The general algebraical expression of this value has just been shown to be $\frac{1}{r} - \overline{\text{ABC.}}$

$$\text{But } \frac{1}{r} = \frac{1}{0{\cdot}5} = 20{\cdot}000$$
$$\text{And } \overline{\text{ABC,}} \quad = 14{\cdot}001 \text{ (68.)}$$

Therefore 5·999 years' purchase is the value required. And if the annual produce of the estate, clear of all deductions, were L.100, the title to the reversion would now be worth L.599. 18s. —, agreeably to No. 76.

177. *Ex.* 2. An annuity for the term of 70 years certain (from this time) is to revert to Q and his heirs at the failure of a life A, now 45 years of age; what is the present value of Q's interest therein, reckoning the interest of money at 5 *per cent.?*

In No. 174 the algebraical expression of the required value is shown to be $\frac{1-v^{70}}{r} - \text{A}$.

$$\text{But } \lambda v = \text{ʌ } 1{\cdot}05 = \bar{1}{\cdot}9788107$$
$$\times\ 70$$
$$v^{70} = {\cdot}032866\,\lambda\,\bar{2}{\cdot}5167490$$
$$1-v^{70} = {\cdot}967134$$
$$\frac{1-v^{70}}{r} = \frac{{\cdot}967134}{{\cdot}05} = 19{\cdot}34268$$
$$\text{Subtract A} = 12{\cdot}64800 \text{ (Tab. VI.)}$$

remains 6·69468 years' purchase; so that if the annuity were L.1000, the value of the reversion would be L.6694. 13s. 7d.

178. *Ex.* 3. An annuity for the term of 70 years certain from this time is to revert to Q and his heirs at the extinction of the survivor of two lives, A and B, now aged 40 and 50 years respectively, the interest of money being 5 *per cent.*; it is required to determine the value of Q's interest in this annuity.

The algebraical expression of the value is, $\frac{1-v^{70}}{r} - \overline{\text{AB}}$ (174 and 171).

$$\text{But by the last example } \frac{1-v^{70}}{r} = 19{\cdot}34268$$
$$\text{and by No. 66, } \overline{\text{AB}} = 15{\cdot}06600$$

so that the required value is 4·27668 years'

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purchase; and if the annuity be L.1000, the present value of the reversion will be L.4276. 13s. 7d.

IV.—Of Assurances on Lives.

179. Let the present value of the assurance (77 and 78) of L.1 on the life of A be denoted by the old English capital $\mathfrak{A}$, and that of an assurance on the joint continuance of any number of lives A, B, C, &c. by $\mathfrak{ABC}$, &c. Also, let the value of an assurance on the joint continuance of any m of them out of the whole number $m+\mu$ be denoted by $\overset{m}{\overline{\mathfrak{ABC}, \&c.}}$

180. And, in every case, let us designate the annual premium (83) for an assurance, by prefixing the character $\odot$ to the symbol for the single premium; so that $\odot\mathfrak{A}$ may denote the annual premium for an assurance on the life of A; $\odot\mathfrak{ABC}$, &c. the same for an assurance on the joint continuance of all the lives, A, B, C, &c.; and $\odot\,\overset{m}{\overline{\mathfrak{ABC}, \&c.}}$ the annual premium for an assurance on the joint continuance of the last m survivors out of the whole number $m+\mu$ of those lives.

181. Then will ${}_{t|}\mathfrak{A}$ and $\odot\,{}_{t|}\mathfrak{A}$, ${}_{t|}\mathfrak{ABC}$, &c. and $\odot\,{}_{t|}\mathfrak{ABC}$, &c., ${}_{t|}\overset{m}{\overline{\mathfrak{ABC}, \&c.}}$ and $\odot\,{}_{t|}\overset{m}{\overline{\mathfrak{ABC}, \&c.}}$ designate the single and annual premiums for assurances on the same life or lives for the term of t years only.

Prob. XI.

182. To determine $\left({}_{t|}\overset{m}{\overline{\mathfrak{ABC}, \&c.}}\right)$ the present value of an assurance on the last m survivors out of $m+\mu$ lives A, B, C, &c. for the term of t years only; that is, the present value of L.1 to be received upon the joint continuance of these last m survivors failing in the term.

Solution.

By reasoning as in No. 79, it will be found that a perpetuity, the first payment of which is to be made at the end of the year in which the last m survivors out of these $m+\mu$ lives may fail in the term, will be of the same present value as $\left(1+\frac{1}{r}=\right)\frac{1}{1-v}$ pounds to be received in the same event (112 and 146); but, in No. 173, the value of the reversion of such a perpetuity in that event was shown to be $\frac{v}{1-v}\left[1-{}_t\overset{m}{\overline{(abc, \&c.)}}v^t\right]-{}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}$

whence it is manifest that ${}_{t|}\overset{m}{\overline{\mathfrak{ABC}, \&c.}}$

$$= v\left[1-{}_t\overset{m}{\overline{(abc, \&c.)}}\,v^t\right]-(1-v)\;{}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}$$

183. Since the annual premium for this assurance must be paid at the commencement of every year in the term, while the last m surviving lives all subsist (83); besides the premium paid down now, one must be paid at the expiration of every year in the term except the last, provided that these last m survivors all outlive it; but the present value of L.1 to be received upon their surviving that last year is ${}_t\overset{m}{\overline{(abc, \&c.)}}v^t$, therefore all the future premiums are now worth ${}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}-{}_t\overset{m}{\overline{(abc, \&c.)}}\,v^t$ years' purchase, and the present value of all the premiums, or the total present value of the assurance, is

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$$\odot\,{}_{t|}\overset{m}{\overline{\mathfrak{ABC}, \&c.}}\left[1-{}_t\overset{m}{\overline{(abc, \&c.)}}\,v^t+{}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}\right]=$$

$$v\left[1-{}_t\overset{m}{\overline{(abc,\&c.)}}v^t\right]-(1-v)\,{}_{t|}\overset{m}{\overline{\text{ABC},\&c.}}=1-{}_t\overset{m}{\overline{(abc,\&c.)}}v^t$$

$$-(1-v)\cdot\left[1-{}_t\overset{m}{\overline{(abc, \&c.)}}v^t+{}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}\right],$$ whence we have

$$\odot\,{}_{t|}\overset{m}{\overline{\mathfrak{ABC}, \&c.}}=\frac{1-{}_t\overset{m}{\overline{(abc, \&c.)}}\,v^t}{1-{}_t\overset{m}{\overline{(abc, \&c.)}}v^t+{}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}}+v-1.$$

184. *Corol.* 1. When (t), the term of the assurance, is not less than the greatest possible joint duration of any m of the proposed lives, ${}_t\overset{m}{\overline{(abc, \&c.)}}=0$, ${}_{t|}\overset{m}{\overline{\text{ABC}, \&c.}}=\overset{m}{\overline{\text{ABC}, \&c.}}$, and the general formulæ of the two preceding numbers become respectively

$$\overset{m}{\overline{\mathfrak{ABC}, \&c.}}=v-(1-v)\,\overset{m}{\overline{\text{ABC}, \&c.}}$$

$$\text{and }\odot\,\overset{m}{\overline{\mathfrak{ABC}, \&c.}}=\frac{1}{1+\overset{m}{\overline{\text{ABC}, \&c.}}}+v-1.$$

185. *Corol.* 2. In the same manner it appears, that, for a single life, $\mathfrak{A}=v-(1-v)\,\text{A}$,

$$\text{and }\odot\mathfrak{A}=\frac{1}{1+\text{A}}+v-1.$$

186. *Corol.* 3. Also that ${}_{t|}\mathfrak{A}=v\,(1-{}_ta\,v^t)-(1-v)\,{}_{t|}\text{A}$

$$\text{or }{}_{t|}\mathfrak{A}=v\left(1-\frac{{}^ta}{a}v^t\right)-(1-v)\cdot\left(\text{A}-\frac{{}^ta}{a}v^t\cdot{}^t\text{A}\right).$$

$$\text{And }\odot\,{}_{t|}\mathfrak{A}=\frac{1-{}_tav^t}{1-{}_ta\,v^t+{}_{t|}\text{A}}+v-1;$$

$$\text{that is, }\odot\,{}_{t|}\mathfrak{A}=\frac{1-\frac{{}^ta}{a}v^t}{1+\text{A}-\frac{{}^ta}{a}v^t\cdot(1+{}^t\text{A})}+v-1.$$

187. *Corol.* 4. When the assurance is on the joint continuance of all the lives, the formulæ of No. 184 become respectively

$$\mathfrak{ABC},\ \&c. = v-(1-v)\ \text{ABC},\ \&c.$$

$$\text{and }\odot\,\mathfrak{ABC},\ \&c.=\frac{1}{1+\text{ABC},\ \&c.}+v-1.$$

And those of numbers 182 and 183,

$${}_{t|}\mathfrak{ABC},\ \&c.=v\left(1-\frac{{}^t(abc,\ \&c.)}{abc,\ \&c.}v^t\right)-(1-v)\times\left[\text{ABC},\ \&c.-\frac{{}^t(abc,\ \&c.)}{abc,\ \&c.}v^t\cdot{}^t(\text{ABC},\ \&c.)\right]$$

and $\odot\,{}_{t|}\mathfrak{ABC}$, &c. =

$$\frac{1-\frac{{}^t(abc,\ \&c.)}{abc,\ \&c.}v^t}{1+\text{ABC},\ \&c.-\frac{{}^t(abc,\ \&c.)}{abc,\ \&c.}v^t\left[1+{}^t(\text{ABC},\ \&c.)\right]},$$

$+v-1.$

188. *Corol.* 5. According as the assurance is in the last survivor of two or of three lives, the formulæ of No. 184 become respectively

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$$\overline{\mathfrak{AB}} = v-(1-v)\,\overline{\text{AB}},$$

$$\text{and } \odot\,\overline{\mathfrak{AB}} = \frac{1}{1+\overline{\text{AB}}}+v-1;$$

$$\text{or } \overline{\mathfrak{ABC}} = v-(1-v)\,\overline{\text{ABC}},$$

$$\text{and } \odot\,\overline{\mathfrak{ABC}} = \frac{1}{1+\overline{\text{ABC}}}+v-1.$$

And those of numbers 182 and 183 become

$$_{\overline{t|}}\overline{\mathfrak{AB}} = v\left[1-{}_t\overline{(ab)}v^t\right]-(1-v)\,{}_{\overline{t|}}\overline{\text{AB}},$$

$$\text{and } \odot\,{}_{\overline{t|}}\overline{\mathfrak{AB}} = \frac{1-{}_t\overline{(ab)}v^t}{1-{}_t\overline{(ab)}v^t+{}_{\overline{t|}}\overline{\text{AB}}}+v-1;$$

$$\text{or } {}_{\overline{t|}}\overline{\mathfrak{ABC}} = v\left[1-{}_t\overline{(abc)}v^t\right]-(1-v)\,{}_{\overline{t|}}\overline{\text{ABC}},$$

$$\text{and } \odot\,{}_{\overline{t|}}\overline{\mathfrak{ABC}} = \frac{1-{}_t\overline{(abc)}v^t}{1-{}_t\overline{(abc)}v^t+{}_{\overline{t|}}\overline{\text{ABC}}}+v-1 \text{ respec-}$$

tively.

Where ${}_t\overline{(ab)} = {}_ta+{}_tb-{}_t(ab)$ (141),

and ${}_t\overline{(abc)} = {}_ta+{}_tb+{}_tc-\left[{}_t(ab)+{}_t(ac)+{}_t(bc)\right]+{}_t(abc)$. (142.)

For the values of $\overline{\text{AB}}$, $\overline{\text{ABC}}$, ${}_{\overline{t|}}\overline{\text{AB}}$, and ${}_{\overline{t|}}\overline{\text{ABC}}$, see numbers 157–159, and 161.

189. *Corol.* 6. When the assurance is on the joint continuance of the two last survivors out of the three lives *A*, *B*, *C*, the formulæ of No. 184 become respectively

$$\overset{2}{\overline{\mathfrak{ABC}}} = v-(1-v)\,\overset{2}{\overline{\text{ABC}}},$$

$$\text{and } \odot\,\overset{2}{\overline{\mathfrak{ABC}}} = \frac{1}{1+\overset{2}{\overline{\text{ABC}}}}+v-1.$$

Those of numbers 182 and 183,

$${}_{\overline{t|}}\overset{2}{\overline{\mathfrak{ABC}}} = v\left[1-{}_t\overset{2}{\overline{(abc)}}\,v^t\right]-(1-v)\,{}_{\overline{t|}}\overset{2}{\overline{\text{ABC}}},$$

$$\text{and } \odot\,{}_{\overline{t|}}\overset{2}{\overline{\mathfrak{ABC}}} = \frac{1-{}_t\overset{2}{\overline{(abc)}}v^t}{1-{}_t\overset{2}{\overline{(abc)}}v^t+{}_{\overline{t|}}\overset{2}{\overline{\text{ABC}}}}+v-1.$$

Where ${}_t\overset{2}{\overline{(abc)}} = {}_t(ab)+{}_t(ac)+{}_t(bc)-2\,{}_t(abc)$. (143.)

For the values of $\overset{2}{\overline{\text{ABC}}}$ and ${}_{\overline{t|}}\overset{2}{\overline{\text{ABC}}}$ see numbers 157, 160, and 161.

190. $v\left[1-{}_t\overset{m}{\overline{(abc,\ \&c.)}}v^t\right]-(1-v)\,{}_{\overline{t|}}\overset{m}{\overline{\text{ABC, \&c.}}}$ the value of an assurance on any life or lives for the term of *t* years, which was given in No. 182, may also be expressed thus:

$$\left[1+{}_{\overline{t|}}\overset{m}{\overline{(\text{ABC, \&c.})}}-{}_t\overset{m}{\overline{(abc,\ \&c.)}}v^t\right]v-{}_{\overline{t|}}\overset{m}{\overline{\text{ABC, \&c.}}}$$

And this, in words at length, is the rule given in No. 93.

191. When *t* is not less than the greatest possible joint duration of any *m* of the proposed lives, the last expression becomes

$$\left(1+\overset{m}{\overline{\text{ABC, \&c.}}}\right)v-\overset{m}{\overline{\text{ABC, \&c.}}}$$

which is also equivalent to the first in No. 184; and, in words at length, is the rule given in No. 97 for determining the value of an assurance on any life or lives for their whole duration.

192. By substituting $\frac{1}{1+r}$ for v (146) in the last expression, it becomes $\frac{1+\overset{m}{\overline{\text{ABC, \&c.}}}}{1+r}-\overset{m}{\overline{\text{ABC, \&c.}}}$

$$=\frac{1-r.\overset{m}{\overline{\text{ABC, \&c.}}}}{1+r}, \text{ or } \frac{\frac{1}{r}-\overset{m}{\overline{\text{ABC, \&c.}}}}{1+\frac{1}{r}}. \text{ And}$$

$$\frac{\frac{1}{r}-\overset{m}{\overline{\text{ABC, \&c.}}}}{1+\frac{1}{r}} = \overset{m}{\overline{\mathfrak{ABC}, \&c.}}$$ is the proposition enunciated in No. 81; $\frac{1}{r}$ being the value of the perpetuity. (112.)

193. Examples of the determination of the single premiums for assurances, and of the derivation of the annual premiums from them, have been given in No. 82–88, also in 95 and 96; but by the algebraical formulæ given here, the annual premiums may be determined directly, without first finding the total present values of the assurances.

194. *Example* 1. Required the annual premium for an assurance on the life *A*, now 50 years of age, interest 5 *per cent.*

According to No. 185, the operation is thus,

$$\left.\begin{aligned} 1+\text{A} &= 12{\cdot}660\ \lambda \\ \frac{1}{1+\text{A}} &= {\cdot}0789890\ \varkappa \end{aligned}\right\}\bar{2}{\cdot}8975663$$

adding $v = {\cdot}9523809$, and subtracting unit,

we have $\odot\,\mathfrak{A}$ ·0313699, agreeably to No. 85.

195. *Ex.* 2. What should the annual premium be for an assurance on the last survivor of three lives *A*, *B*, and *C*, now aged 50, 55, and 60 years respectively, rate of interest 5 *per cent.?*

Operation by No. 188.

$$\left.\begin{aligned} (68)\ 1+\overline{\text{ABC}} &= 15{\cdot}001\ \lambda \\ \frac{1}{1+\overline{\text{ABC}}} &= {\cdot}0666622\ \varkappa \end{aligned}\right\}\bar{2}{\cdot}8238798$$

$$v = {\cdot}9523809$$

$$\odot\,\overline{\mathfrak{ABC}} = {\cdot}0190431, \text{ agreeably to No. 88.}$$

196. *Ex.* 3. Required the annual premium for an assurance for 10 years only, on a life now 45 years of age, interest 5 *per cent.*

Operation according to No. 186.

$$\begin{array}{rll}
v^{10} = & {\cdot}613913\ \lambda & \bar{1}{\cdot}7881068 \\
{}^{10}a = & 4073\ \lambda & 3{\cdot}6099144 \\
a = & 4727\ \varkappa & \bar{4}{\cdot}3254144 \\
{}_{10}av^{10} = & {\cdot}528976\ \lambda & \bar{1}{\cdot}7234356 \\
1+{}^{10}\text{A} = & 11{\cdot}347\ \lambda & 1{\cdot}0548811 \\
\text{Subtract} & 6{\cdot}002\ \lambda & 0{\cdot}7783167 \\
\text{from } 1+\text{A} = & 13{\cdot}648 & \\
\text{remains} & 7{\cdot}646\ \varkappa & \bar{1}{\cdot}1165657 \\
1-{}_{10}av^{10} = & {\cdot}471024\ \lambda & \bar{1}{\cdot}6730430 \\
 & {\cdot}061604\ \lambda & \bar{2}{\cdot}7896087 \\
v = & {\cdot}952381 &
\end{array}$$

$$\odot\,{}_{\overline{10|}}\mathfrak{A} = {\cdot}013985, \text{ agreeably to No. 96.}$$

What has been advanced from number 99 to 109 needs no algebraical illustration.

TABLE I.

Showing the present Value of One Pound to be received at the End of any Number of Years not exceeding 50.

(See No. 9——12 of the preceding Article.)

Years.	2 per Cent.	2½ per Cent.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	Years.
1	·980392	·975610	·970874	·961538	·952381	·943396	·934579	·925926	·917431	1
2	·961169	·951814	·942596	·924556	·907029	·889996	·873439	·857339	·841680	2
3	·942322	·928599	·915142	·888996	·863838	·839619	·816298	·793832	·772183	3
4	·923845	·905951	·888487	·854804	·822702	·792094	·762895	·735030	·708425	4
5	·905731	·883854	·862609	·821927	·783526	·747258	·712986	·680583	·649931	5
6	·887971	·862297	·837484	·790315	·746215	·704961	·666342	·630170	·596267	6
7	·870560	·841265	·813092	·759918	·710681	·665057	·622750	·583490	·547034	7
8	·853490	·820747	·789409	·730690	·676839	·627412	·582009	·540269	·501866	8
9	·836755	·800728	·766417	·702587	·644609	·591898	·543934	·500249	·460428	9
10	·820348	·781198	·744094	·675564	·613913	·558395	·508349	·463193	·422411	10
11	·804263	·762145	·722421	·649581	·584679	·526788	·475093	·428883	·387533	11
12	·788493	·743556	·701380	·624597	·556837	·496969	·444012	·397114	·355535	12
13	·773033	·725420	·680951	·600574	·530321	·468839	·414964	·367698	·326179	13
14	·757875	·707727	·661118	·577475	·505068	·442301	·387817	·340461	·299246	14
15	·743015	·690466	·641862	·555265	·481017	·417265	·362446	·315242	·274538	15
16	·728446	·673625	·623167	·533908	·458112	·393646	·338735	·291890	·251870	16
17	·714163	·657195	·605016	·513373	·436297	·371364	·316574	·270269	·231073	17
18	·700159	·641166	·587395	·493628	·415521	·350344	·295864	·250249	·211994	18
19	·686431	·625528	·570286	·474642	·395734	·330513	·276508	·231712	·194490	19
20	·672971	·610271	·553676	·456387	·376889	·311805	·258419	·214548	·178431	20
21	·659776	·595386	·537549	·438834	·358942	·294155	·241513	·198656	·163698	21
22	·646839	·580865	·521893	·421955	·341850	·277505	·225713	·183941	·150182	22
23	·634156	·566697	·506692	·405726	·325571	·261797	·210947	·170315	·137781	23
24	·621721	·552875	·491934	·390121	·310068	·246979	·197147	·157699	·126405	24
25	·609531	·539391	·477606	·375117	·295303	·232999	·184249	·146018	·115968	25
26	·597579	·526235	·463695	·360689	·281241	·219810	·172195	·135202	·106393	26
27	·585862	·513400	·450189	·346817	·267848	·207368	·160930	·125187	·097608	27
28	·574375	·500878	·437077	·333477	·255094	·195630	·150402	·115914	·089548	28
29	·563112	·488661	·424346	·320651	·242946	·184557	·140563	·107328	·082155	29
30	·552071	·476743	·411987	·308319	·231377	·174110	·131367	·099377	·075371	30
31	·541246	·465115	·399987	·296460	·220359	·164255	·122773	·092016	·069148	31
32	·530633	·453771	·388337	·285058	·209866	·154957	·114741	·085200	·063438	32
33	·520229	·442703	·377026	·274094	·199873	·146186	·107235	·078889	·058200	33
34	·510028	·431905	·366045	·263552	·190355	·137912	·100219	·073045	·053395	34
35	·500028	·421371	·355383	·253415	·181290	·130105	·093663	·067635	·048986	35
36	·490223	·411094	·345032	·243669	·172657	·122741	·087535	·062625	·044941	36
37	·480611	·401067	·334983	·234297	·164436	·115793	·081809	·057986	·041231	37
38	·471187	·391285	·325226	·225285	·156605	·109239	·076457	·053690	·037826	38
39	·461948	·381741	·315754	·216621	·149148	·103056	·071455	·049713	·034703	39
40	·452890	·372431	·306557	·208289	·142046	·097222	·066780	·046031	·031838	40
41	·444010	·363347	·297628	·200278	·135282	·091719	·062412	·042621	·029209	41
42	·435304	·354485	·288959	·192575	·128840	·086527	·058329	·039464	·026797	42
43	·426769	·345839	·280543	·185168	·122704	·081630	·054513	·036541	·024584	43
44	·418401	·337404	·272372	·178046	·116861	·077009	·050946	·033834	·022555	44
45	·410197	·329174	·264439	·171198	·111297	·072650	·047613	·031328	·020692	45
46	·402154	·321146	·256737	·164614	·105997	·068538	·044499	·029007	·018984	46
47	·394268	·313313	·249259	·158283	·100949	·064658	·041587	·026859	·017416	47
48	·386538	·305671	·241999	·152195	·096142	·060998	·038867	·024869	·015978	48
49	·378958	·298216	·234950	·146341	·091564	·057546	·036324	·023027	·014659	49
50	·371528	·290942	·228107	·140713	·087204	·054288	·033948	·021321	·013449	50

TABLE II.

Showing the present Value of an Annuity of One Pound for any Number of Years not exceeding **50**.

(No. 9——12.)

Years.	2 per Cent.	2½ per Cent.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	9 per Cent.	Years.
1	·9804	·9756	·9709	·9615	·9524	·9434	·9346	·9259	·9174	1
2	1·9416	1·9274	1·9135	1·8861	1·8594	1·8334	1·8080	1·7833	1·7591	2
3	2·8839	2·8560	2·8286	2·7751	2·7232	2·6730	2·6243	2·5771	2·5313	3
4	3·8077	3·7620	3·7171	3·6299	3·5460	3·4651	3·3872	3·3121	3·2397	4
5	4·7135	4·6458	4·5797	4·4518	4·3295	4·2124	4·1002	3·9927	3·8897	5
6	5·6014	5·5081	5·4172	5·2421	5·0757	4·9173	4·7665	4·6229	4·4859	6
7	6·4720	6·3494	6·2303	6·0021	5·7864	5·5824	5·3893	5·2064	5·0330	7
8	7·3255	7·1701	7·0197	6·7327	6·4632	6·2098	5·9713	5·7466	5·5348	8
9	8·1622	7·9709	7·7861	7·4353	7·1078	6·8017	6·5152	6·2469	5·9952	9
10	8·9826	8·7521	8·5302	8·1109	7·7217	7·3601	7·0236	6·7101	6·4177	10
11	9·7868	9·5142	9·2526	8·7605	8·3064	7·8869	7·4987	7·1390	6·8052	11
12	10·5753	10·2578	9·9540	9·3851	8·8633	8·3838	7·9427	7·5361	7·1607	12
13	11·3484	10·9832	10·6350	9·9856	9·3936	8·8527	8·3577	7·9038	7·4869	13
14	12·1062	11·6909	11·2961	10·5631	9·8986	9·2950	8·7455	8·2442	7·7862	14
15	12·8493	12·3814	11·9379	11·1184	10·3797	9·7122	9·1079	8·5595	8·0607	15
16	13·5777	13·0550	12·5611	11·6523	10·8378	10·1059	9·4466	8·8514	8·3126	16
17	14·2919	13·7122	13·1661	12·1657	11·2741	10·4773	9·7632	9·1216	8·5436	17
18	14·9920	14·3534	13·7535	12·6593	11·6896	10·8276	10·0591	9·3719	8·7556	18
19	15·6785	14·9789	14·3238	13·1339	12·0853	11·1581	10·3356	9·6036	8·9501	19
20	16·3514	15·5892	14·8775	13·5903	12·4622	11·4699	10·5940	9·8181	9·1285	20
21	17·0112	16·1845	15·4150	14·0292	12·8212	11·7641	10·8355	10·0168	9·2922	21
22	17·6580	16·7654	15·9369	14·4511	13·1630	12·0416	11·0612	10·2007	9·4424	22
23	18·2922	17·3321	16·4436	14·8568	13·4886	12·3034	11·2722	10·3711	9·5802	23
24	18·9139	17·8850	16·9355	15·2470	13·7986	12·5504	11·4693	10·5288	9·7066	24
25	19·5235	18·4244	17·4131	15·6221	14·0939	12·7834	11·6536	10·6748	9·8226	25
26	20·1210	18·9506	17·8768	15·9828	14·3752	13·0032	11·8258	10·8100	9·9290	26
27	20·7069	19·4640	18·3270	16·3296	14·6430	13·2105	11·9867	10·9352	10·0266	27
28	21·2813	19·9649	18·7641	16·6631	14·8981	13·4062	12·1371	11·0511	10·1161	28
29	21·8444	20·4535	19·1885	16·9837	15·1411	13·5907	12·2777	11·1584	10·1983	29
30	22·3965	20·9303	19·6004	17·2920	15·3725	13·7648	12·4090	11·2578	10·2737	30
31	22·9377	21·3954	20·0004	17·5885	15·5928	13·9291	12·5318	11·3498	10·3428	31
32	23·4683	21·8492	20·3888	17·8736	15·8027	14·0840	12·6466	11·4350	10·4062	32
33	23·9886	22·2919	20·7658	18·1476	16·0025	14·2302	12·7538	11·5139	10·4644	33
34	24·4986	22·7238	21·1318	18·4112	16·1929	14·3681	12·8540	11·5869	10·5178	34
35	24·9986	23·1452	21·4872	18·6646	16·3742	14·4982	12·9477	11·6546	10·5668	35
36	25·4888	23·5563	21·8323	18·9083	16·5469	14·6210	13·0352	11·7172	10·6118	36
37	25·9695	23·9573	22·1672	19·1426	16·7113	14·7368	13·1170	11·7752	10·6530	37
38	26·4406	24·3486	22·4925	19·3679	16·8679	14·8460	13·1935	11·8289	10·6908	38
39	26·9026	24·7303	22·8082	19·5845	17·0170	14·9491	13·2649	11·8786	10·7255	39
40	27·3555	25·1028	23·1148	19·7928	17·1591	15·0463	13·3317	11·9246	10·7574	40
41	27·7995	25·4661	23·4124	19·9931	17·2944	15·1380	13·3941	11·9672	10·7866	41
42	28·2348	25·8206	23·7014	20·1856	17·4232	15·2245	13·4524	12·0067	10·8134	42
43	28·6616	26·1664	23·9819	20·3708	17·5459	15·3062	13·5070	12·0432	10·8380	43
44	29·0800	26·5038	24·2543	20·5488	17·6628	15·3832	13·5579	12·0771	10·8605	44
45	29·4902	26 8330	24·5187	20·7200	17·7741	15·4558	13·6055	12·1084	10·8812	45
46	29·8923	27·1542	24·7754	20·8847	17·8801	15·5244	13·6500	12·1374	10·9002	46
47	30·2866	27·4675	25·0247	21·0429	17·9810	15·5890	13·6916	12·1643	10·9176	47
48	30·6731	27·7732	25·2667	21·1951	18·0772	15·6500	13·7305	12·1891	10·9336	48
49	31·0521	28·0714	25·5017	21·3415	18·1687	15·7076	13·7668	12·2122	10·9482	49
50	31·4236	28·3623	25·7298	21·4822	18·2559	15·7619	13·8007	12·2335	10·9617	50
Perp.	50·0000	40·0000	33·3333	25·0000	20·0000	16·6667	14·2857	12·5000	11·1111	Perp.

TABLE III.

Showing the Sum to which One Pound will increase when improved at Compound Interest during any Number of Years not exceeding 50.

(No. 9——12.)

Years.	2 per Cent.	2½ per Cent.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	8 per Cent.	Years.
1	1·02000	1·02500	1·030000	1·040000	1·050000	1·060000	1·070000	1·080000	1
2	1·04040	1·05063	1·060900	1·081600	1·102500	1·123600	1·144900	1·166400	2
3	1·06121	1·07689	1·092727	1·124864	1·157625	1·191016	1·225043	1·259712	3
4	1·08243	1·10381	1·125509	1·169859	1·215506	1·262477	1·310796	1·360489	4
5	1·10408	1·13141	1·159274	1·216653	1·276282	1·338226	1·402552	1·469328	5
6	1·12616	1·15969	1·194052	1·265319	1·340096	1·418519	1·500730	1·586874	6
7	1·14869	1·18869	1·229874	1·315932	1·407100	1·503630	1·605781	1·713824	7
8	1·17166	1·21840	1·266770	1·368569	1·477455	1·593848	1·718186	1·850930	8
9	1·19509	1·24886	1·304773	1·423312	1·551328	1·689479	1·838459	1·999005	9
10	1·21899	1·28008	1·343916	1·480244	1·628895	1·790848	1·967151	2·158925	10
11	1·24337	1·31209	1·384234	1·539454	1·710339	1·898299	2·104852	2·331639	11
12	1·26824	1·34489	1·425761	1·601032	1·795856	2·012196	2·252192	2·518170	12
13	1·29361	1·37851	1·468534	1·665074	1·885649	2·132928	2·409845	2·719624	13
14	1·31948	1·41297	1·512590	1·731676	1·979932	2·260904	2·578534	2·937194	14
15	1·34587	1·44830	1·557967	1·800944	2·078928	2·396558	2·759032	3·172169	15
16	1·37279	1·48451	1·604706	1·872981	2·182875	2·540352	2·952164	3·425943	16
17	1·40024	1·52162	1·652848	1·947901	2·292018	2·692773	3·158815	3·700018	17
18	1·42825	1·55966	1·702433	2·025817	2·406619	2·854339	3·379932	3·996020	18
19	1·45681	1·59865	1·753506	2·106849	2·526950	3·025600	3·616528	4·315701	19
20	1·48595	1·63862	1·806111	2·191123	2·653298	3·207135	3·869684	4·660957	20
21	1·51567	1·67958	1·860295	2·278768	2·785963	3·399564	4·140562	5·033834	21
22	1·54598	1·72157	1·916103	2·369919	2·925261	3·603537	4·430402	5·436540	22
23	1·57690	1·76461	1·973587	2·464716	3·071524	3·819750	4·740530	5·871464	23
24	1·60844	1·80873	2·032794	2·563304	3·225100	4·048935	5·072367	6·341181	24
25	1·64061	1·85394	2·093778	2·665836	3·386355	4·291871	5·427433	6·848475	25
26	1·67342	1·90029	2·156591	2·772470	3·555673	4·549383	5·807353	7·396353	26
27	1·70689	1·94780	2·221289	2·883369	3·733456	4·822346	6·213868	7·988061	27
28	1·74102	1·99650	2·287928	2·998703	3·920129	5·111687	6·648838	8·627106	28
29	1·77584	2·04641	2·356566	3·118651	4·116136	5·418388	7·114257	9·317275	29
30	1·81136	2·09757	2·427262	3·243398	4·321942	5·743491	7·612255	10·062657	30
31	1·84759	2·15001	2·500080	3·373133	4·538039	6·088101	8·145113	10·867669	31
32	1·88454	2·20376	2·575083	3·508059	4·764941	6·453387	8·715271	11·737083	32
33	1·92223	2·25885	2·652335	3·648381	5·003189	6·840590	9·325340	12·676050	33
34	1·96068	2·31532	2·731905	3·794316	5·253348	7·251025	9·978114	13·690134	34
35	1·99989	2·37321	2·813862	3·946089	5·516015	7·686087	10·676581	14·785344	35
36	2·03989	2·43254	2·898278	4·103933	5·791816	8·147252	11·423942	15·968172	36
37	2·08069	2·49335	2·985227	4·268090	6·081407	8·636087	12·223618	17·245626	37
38	2·12230	2·55568	3·074783	4·438813	6·385477	9·154252	13·079271	18·625276	38
39	2·16474	2·61957	3·167027	4·616366	6·704751	9·703507	13·994820	20·115298	39
40	2·20804	2·68506	3·262038	4·801021	7·039989	10·285718	14·974458	21·724522	40
41	2·25220	2·75219	3·359899	4·993061	7·391988	10·902861	16·022670	23·462483	41
42	2·29724	2·82100	3·460696	5·192784	7·761588	11·557033	17·144257	25·339482	42
43	2·34319	2·89152	3·564517	5·400495	8·149667	12·250455	18·344355	27·366640	43
44	2·39005	2·96381	3·671452	5·616515	8·557150	12·985482	19·628460	29·555972	44
45	2·43785	3·03790	3·781596	5·841176	8·985008	13·764611	21·002452	31·920449	45
46	2·48661	3·11385	3·895044	6·074823	9·434258	14·590487	22·472623	34·474085	46
47	2·53634	3·19170	4·011895	6·317816	9·905971	15·465917	24·045707	37·232012	47
48	2·58707	3·27149	4·132252	6·570528	10·401270	16·393872	25·728907	40·210573	48
49	2·63881	3·35328	4·256219	6·833349	10·921333	17·377504	27·529930	43·427419	49
50	2·69159	3·43711	4·383906	7·106683	11·467400	18·420154	29·457025	46·901613	50

TABLE IV.

Showing the Amount to which One Pound *per Annum* will increase at Compound Interest in any Number of Years not exceeding 50.

(No. 9——12.)

Years.	2 per Cent.	2½ per Cent.	3 per Cent.	4 per Cent.	5 per Cent.	6 per Cent.	7 per Cent.	Years.
1	1·0000	1·0000	1·000000	1·000000	1·000000	1·000000	1·000000	1
2	2·0200	2·0250	2·030000	2·040000	2·050000	2·060000	2·070000	2
3	3·0604	3·0756	3·090900	3·121600	3·152500	3·183600	3·214900	3
4	4·1216	4·1525	4·183627	4·246464	4·310125	4·374616	4·439943	4
5	5·2040	5·2563	5·309136	5·416323	5·525631	5·637093	5·750739	5
6	6·3081	6·3877	6·468410	6·632975	6·801913	6·975319	7·153291	6
7	7·4343	7·5474	7·662462	7·898294	8·142008	8·393838	8·654021	7
8	8·5830	8·7361	8·892336	9·214226	9·549109	9·897468	10·259803	8
9	9·7546	9·9545	10·159106	10·582795	11·026564	11·491316	11·977989	9
10	10·9497	11·2034	11·463879	12·006107	12·577893	13·180795	13·816448	10
11	12·1687	12·4835	12·807796	13·486351	14·206787	14·971643	15·783599	11
12	13·4121	13·7956	14·192030	15·025805	15·917127	16·869941	17·888451	12
13	14·6803	15·1404	15·617790	16·626838	17·712983	18·882138	20·140643	13
14	15·9739	16·5190	17·086324	18·291911	19·598632	21·015066	22·550488	14
15	17·2934	17·9319	18·598914	20·023588	21·578564	23·275970	25·129022	15
16	18·6393	19·3802	20·156881	21·824531	23·657492	25·672528	27·888054	16
17	20·0121	20·8647	21·761588	23·697512	25·840366	28·212880	30·840217	17
18	21·4123	22·3863	23·414435	25·645413	28·132385	30·905653	33·999033	18
19	22·8406	23·9460	25·116868	27·671229	30·539004	33·759992	37·378965	19
20	24·2974	25·5447	26·870374	29·778079	33·065954	36·785591	40·995492	20
21	25·7833	27·1833	28·676486	31·969202	35·719252	39·992727	44·865177	21
22	27·2990	28·8629	30·536780	34·247970	38·505214	43·392290	49·005739	22
23	28·8450	30·5844	32·452884	36·617889	41·430475	46·995828	53·436141	23
24	30·4219	32·3490	34·426470	39·082604	44·501999	50·815577	58·176671	24
25	32·0303	34·1578	36·459264	41·645908	47·727099	54·864512	63·249038	25
26	33·6709	36·0117	38·553042	44·311745	51·113454	59·156383	68·676470	26
27	35·3443	37·9120	40·709634	47·084214	54·669126	63·705766	74·483823	27
28	37·0512	39·8598	42·930923	49·967583	58·402583	68·528112	80·697691	28
29	38·7922	41·8563	45·218850	52·966286	62·322712	73·639798	87·346529	29
30	40·5681	43·9027	47·575416	56·084938	66·438848	79·058186	94·460786	30
31	42·3794	46·0003	50·002678	59·328335	70·760790	84·801677	102·073041	31
32	44·2270	48·1503	52·502759	62·701469	75·298829	90·889778	110·218154	32
33	46·1116	50·3540	55·077841	66·209527	80·063771	97·343165	118·933425	33
34	48·0338	52·6129	57·730177	69·857909	85·066959	104·183755	128·258765	34
35	49·9945	54·9282	60·462082	73·652225	90·320307	111·434780	138·236878	35
36	51·9944	57·3014	63·275944	77·598314	95·836323	119·120867	148·913460	36
37	54·0343	59·7339	66·174223	81·702246	101·628139	127·268119	160·337402	37
38	56·1149	62·2273	69·159449	85·970336	107·709546	135·904206	172·561020	38
39	58·2372	64·7830	72·234233	90·409150	114·095023	145·058458	185·640292	39
40	60·4020	67·4026	75·401260	95·025516	120·799774	154·761966	199·635112	40
41	62·6100	70·0876	78·663298	99·826536	127·839763	165·047684	214·609570	41
42	64·8622	72·8398	82·023196	104·819598	135·231751	175·950545	230·632240	42
43	67·1595	75·6608	85·483892	110·012382	142·993339	187·507577	247·776496	43
44	69·5027	78·5523	89·048409	115·412877	151·143006	199·758032	266·120851	44
45	71·8927	81·5161	92·719861	121·029392	159·700156	212·743514	285·749311	45
46	74·3306	84·5540	96·501457	126·870568	168·685164	226·508125	306·751763	46
47	76·8172	87·6679	100·396501	132·945390	178·119422	241·098612	329·224386	47
48	79·3535	90·8596	104·408396	139·263206	188·025393	256·564529	353·270093	48
49	81·9406	94·1311	108·540648	145·833734	198·426663	272·958401	378·999000	49
50	84·5794	97·4843	112·796867	152·667084	209·347996	290·335905	406·528929	50

TABLE V.

Exhibiting the Law of Mortality at *Carlisle*. (No. 32.)

Age.	Number who complete that Age.	Number who die in the next interval.	Age.	Number who complete that Year.	Number who die in their next Year.	Age.	Number who complete that Year.	Number who die in their next Year.
0	10000	533	32	5528	56	69	2525	124
1 Month	9467	154	33	5472	55	70	2401	124
2 Months	9313	87	34	5417	55	71	2277	134
3	9226	256	35	5362	55	72	2143	146
6	8970	255	36	5307	56	73	1997	156
9	8715	254	37	5251	57	74	1841	166
1 Year	8461	682	38	5194	58	75	1675	160
2 Years	7779	505	39	5136	61	76	1515	156
3	7274	276	40	5075	66	77	1359	146
4	6998	201	41	5009	69	78	1213	132
5	6797	121	42	4940	71	79	1081	128
6	6676	82	43	4869	71	80	953	116
7	6594	58	44	4798	71	81	837	112
8	6536	43	45	4727	70	82	725	102
9	6493	33	46	4657	69	83	623	94
10	6460	29	47	4588	67	84	529	84
11	6431	31	48	4521	63	85	445	78
12	6400	32	49	4458	61	86	367	71
13	6368	33	50	4397	59	87	296	64
14	6335	35	51	4338	62	88	232	51
15	6300	39	52	4276	65	89	181	39
16	6261	42	53	4211	68	90	142	37
17	6219	43	54	4143	70	91	105	30
18	6176	43	55	4073	73	92	75	21
19	6133	43	56	4000	76	93	54	14
20	6090	43	57	3924	82	94	40	10
21	6047	42	58	3842	93	95	30	7
22	6005	42	59	3749	106	96	23	5
23	5963	42	60	3643	122	97	18	4
24	5921	42	61	3521	126	98	14	3
25	5879	43	62	3395	127	99	11	2
26	5836	43	63	3268	125	100	9	2
27	5793	45	64	3143	125	101	7	2
28	5748	50	65	3018	124	102	5	2
29	5698	56	66	2894	123	103	3	2
30	5642	57	67	2771	123	104	1	1
31	5585	57	68	2648	123			

TABLE VI.

Showing the Value of an Annuity on a Single Life at every Age, according to the Carlisle Table of Mortality, when the Rate of Interest is *Five per Cent.* (No. 65.)

Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.	Age.	Value.
0	12·083	18	15·987	35	14·127	52	11·154	69	6·643	86	2·830
1	13·995	19	15·904	36	13·987	53	10·892	70	6·336	87	2·685
2	14·983	20	15·817	37	13·843	54	10·624	71	6·015	88	2·597
3	15·824	21	15·726	38	13·695	55	10·347	72	5·711	89	2·495
4	16·271	22	15·628	39	13·542	56	10·063	73	5·435	90	2·339
5	16·590	23	15·525	40	13·390	57	9·771	74	5·190	91	2·321
6	16·735	24	15·417	41	13·245	58	9·478	75	4·989	92	2·412
7	16·790	25	15·303	42	13·101	59	9·199	76	4·792	93	2·518
8	16·786	26	15·187	43	12·957	60	8·940	77	4·609	94	2·569
9	16·742	27	15·065	44	12·806	61	8·712	78	4·422	95	2·596
10	16·669	28	14·942	45	12·648	62	8·487	79	4·210	96	2·555
11	16·581	29	14·827	46	12·480	63	8·258	80	4·015	97	2·428
12	16·494	30	14·723	47	12·301	64	8·016	81	3·799	98	2·278
13	16·406	31	14·617	48	12·107	65	7·765	82	3·606	99	2·045
14	16·316	32	14·506	49	11·892	66	7·503	83	3·406	100	1·624
15	16·227	33	14·387	50	11·660	67	7·227	84	3·211	101	1·192
16	16·144	34	14·260	51	11·410	68	6·941	85	3·009	102	0·753
17	16·066									103	0·317

TABLE VII.

Showing the Value of an Annuity on the Joint Continuance of Two Lives according to the Carlisle Table of Mortality, when the difference of their ages is five years, and the Rate of Interest *Five per Cent.* (No. 65.)

Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.
0 & 5	10·551	20 & 25	13·398	40 & 45	10·598	59 & 64	6·127	79 & 84	2·045
1 & 6	12·331	21 & 26	13·272	41 & 46	10·444	60 & 65	5·895	80 & 85	1·895
2 & 7	13·258	22 & 27	13·137	42 & 47	10·287	61 & 66	5·678	81 & 86	1·747
3 & 8	14·019	23 & 28	13·000	43 & 48	10·121	62 & 67	5·458	82 & 87	1·626
4 & 9	14·402	24 & 29	12·867	44 & 49	9·937	63 & 68	5·230	83 & 88	1·535
5 & 10	14·649	25 & 30	12·742	45 & 50	9·737	64 & 69	4·988	84 & 89	1·433
6 & 11	14·731	26 & 31	12·615	46 & 51	9·519	65 & 70	4·737	85 & 90	1·279
7 & 12	14·736	27 & 32	12·482	47 & 52	9·292	66 & 71	4·469	86 & 91	1·203
8 & 13	14·689	28 & 33	12·344	48 & 53	9·054	67 & 72	4·207	87 & 92	1·192
9 & 14	14·606	29 & 34	12·208	49 & 54	8·799	68 & 73	3·961	88 & 93	1·219
10 & 15	14·500	30 & 35	12·078	50 & 55	8·528	69 & 74	3·731	89 & 94	1·214
11 & 16	14·389	31 & 36	11·944	51 & 56	8·242	70 & 75	3·528	90 & 95	1·167
12 & 17	14·284	32 & 37	11·806	52 & 57	7·950	71 & 76	3·319	91 & 96	1·161
13 & 18	14·178	33 & 38	11·661	53 & 58	7·657	72 & 77	3·127	92 & 97	1·181
14 & 19	14·069	34 & 39	11·508	54 & 59	7·375	73 & 78	2·948	93 & 98	1·215
15 & 20	13·959	35 & 40	11·354	55 & 60	7·106	74 & 79	2·767	94 & 99	1·191
16 & 21	13·853	36 & 41	11·204	56 & 61	6·860	75 & 80	2·623	95 & 100	1·038
17 & 22	13·746	37 & 42	11·056	57 & 62	6·615	76 & 81	2·467	96 & 101	0·828
18 & 23	13·636	38 & 43	10·907	58 & 63	6·370	77 & 82	2·333	97 & 102	0·555
19 & 24	13·520	39 & 44	10·753			78 & 83	2·194	98 & 103	0·249

TABLE VIII.

Showing the Value of an Annuity on the Joint Continuance of Two Lives according to the Carlisle Table of Mortality, when the difference of their Ages is ten years, and the Rate of Interest *Five per Cent.* (No. 65.)

Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.	Ages.	Value.
0 & 10	10·649	19 & 29	13·117	38 & 48	10·396	56 & 66	6·156	75 & 85	2·100
1 & 11	12·275	20 & 30	13·008	39 & 49	10·195	57 & 67	5·881	76 & 86	1·956
2 & 12	13·087	21 & 31	12·896	40 & 50	9·984	58 & 68	5·600	77 & 87	1·838
3 & 13	13·769	22 & 32	12·776	41 & 51	9·766	59 & 69	5·319	78 & 88	1·759
4 & 14	14·106	23 & 33	12·648	42 & 52	9·548	60 & 70	5·044	79 & 89	1·657
5 & 15	14·334	24 & 34	12·510	43 & 53	9·329	61 & 71	4·779	80 & 90	1·515
6 & 16	14·419	25 & 35	12·365	44 & 54	9·104	62 & 72	4·529	81 & 91	1·450
7 & 17	14·432	26 & 36	12·214	45 & 55	8·870	63 & 73	4·302	82 & 92	1·460
8 & 18	14·395	27 & 37	12·058	46 & 56	8·626	64 & 74	4·094	83 & 93	1·479
9 & 19	14·321	28 & 38	11·900	47 & 57	8·372	65 & 75	3·921	84 & 94	1·468
10 & 20	14·221	29 & 39	11·747	48 & 58	8·111	66 & 76	3·746	85 & 95	1·443
11 & 21	14·106	30 & 40	11·607	49 & 59	7·851	67 & 77	3·580	86 & 96	1·397
12 & 22	13·987	31 & 41	11·474	50 & 60	7·601	68 & 78	3·407	87 & 97	1·324
13 & 23	13·864	32 & 42	11·342	51 & 61	7·370	69 & 79	3·210	88 & 98	1·280
14 & 24	13·737	33 & 43	11·207	52 & 62	7·142	70 & 80	3·020	89 & 99	1·192
15 & 25	13·608	34 & 44	11·063	53 & 63	6·911	71 & 81	2·807	90 & 100	0·950
16 & 26	13·483	35 & 45	10·912	54 & 64	6·669	72 & 82	2·616	91 & 101	0·733
17 & 27	13·359	36 & 46	10·750	55 & 65	6·418	73 & 83	2·430	92 & 102	0·508
18 & 28	13·235	37 & 47	10·579			74 & 84	2·260	93 & 103	0·235

(J. M.)

ANNULAR, resembling a ring or circle.

ANNULAR CRYSTAL, in *Mineralogy*, is a hexahedral prism with six, or an octahedral prism with eight marginal faces disposed in a ring about the base; or these prisms truncated on all their terminal edges.

ANNULAR ECLIPSE, in *Astronomy*, is caused by the dark body of the moon intervening so as to obscure the whole of the sun's disc except a marginal ring of light.

ANNULARIA, Sternberg's designation for a fossil genus of plants of the coal formation, with leaves disposed in whorls.

ANNULET, a little circle, borne as a charge in coats of arms, as also added to them as a *difference*. Among the Romans it represented liberty and nobility. It also denotes strength and eternity, by reason of its endless form.

ANNULOSA (from *annulus*, a ring or segment), a term in zoology, applied by naturalists to a great division of the animal kingdom. It contains five classes, viz., CRUSTACEA, MYRIOPODA, ARACHNIDES, INSECTA, and VERMES.

ANNUNCIADA, ANNUNTIADA, or ANNUNCIATA, an order of knighthood in Savoy, instituted by Amadeus I., in the year 1049. Their collar was of 15 links, interwoven one with another in form of a true lover's knot; and the motto F. E. R. T., signifying *Fortitudo ejus Rhodum tenuit.* Amadeus VIII. gave the name *Annunciada* to this order, which was formerly known by that of *the knot of love;* changing at the same time the image of St Maurice, patron of Savoy, which hung at the collar, for that of the Virgin Mary; and, instead of the motto above mentioned, substituting the words of the angel's salutation.

ANNUNCIATION, the tidings brought by the angel Gabriel to the Virgin Mary of the incarnation of Christ. Annunciation is also a festival kept by the church on the 25th of March in commemoration of these tidings. This festival appears to be of very great antiquity. There is mention made of it in a sermon which goes under the name of Athanasius. Others carry it up to the time of Gregory Thaumaturgus, because there is a sermon likewise attributed to him upon the same subject. But the best critics reject both these writings as spurious. However, it is certain that this festival was observed before the time of the council of Trullo, in which there is a canon forbidding the celebration of all festivals in Lent excepting the Lord's Day and the Feast of the Annunciation; so that we may date its origin from the seventh century. In the Romish church, on this feast, the pope performs the ceremony of marrying or cloistering a certain number of maidens, who are presented to him in the church, clothed in white serge, and muffled up from head to foot. An officer stands by, with purses containing notes of 50 crowns for those who make choice of marriage, and notes of 100 for those who choose the veil.

ANNUNCIATION is likewise a title given by the Jews to a part of the ceremony of the Passover.

ANNUS DELIBERANDI, in *Scots Law*, the space of a year which is allowed an heir for deliberating whether he will enter on possession.

ANOA, a quadruped, seemingly of the antelope genus, the horns of which have lately been brought from Celebes; but it is otherwise unknown to naturalists.

ANODYNE (from α, negative, and ὀδύνη, *pain*), a term applied to medicines which ease pain and procure sleep.

ANOMALISTICAL YEAR, in *Astronomy*, the time that the earth takes to pass through her orbit: it is also called the *Periodical Year*. The space of time belonging to this year is greater than the tropical year, on account of the precession of the equinoxes.

ANOMALOUS (from α, priv., and νόμος a law), a term applied to whatever is irregular, or deviates from the rule observed by other things of the like nature.

ANOMŒANS, in *Ecclesiastical History*, the name by which the pure Arians were called in the fourth century, in contradistinction to the Semi-Arians. The word is derived from the Greek ἀνόμοιος, *different, dissimilar;* for the pure Arians asserted that the Son was of a nature different from, and in nothing like, that of the Father; whereas the Semi-Arians acknowledged a likeness of nature in the Son, at the same time that they denied, with the pure Arians, the consubstantiality of the Word. The Semi-Arians condemned the Anomœans in the council of Seleucia; and the Anomœans, in their turn, condemned the Semi-Arians in the councils of Constantinople and Antioch, erasing the word ὅμοιος, *like*, out of the formula of Rimini and that of Constantinople.

ANONYMOUS (α, priv., and ὄνομα), something that is nameless, or of which the name is concealed. It is a term applied to books and to contributions to journals and other periodical works published without the name of the author.

Anonymous writing is, no doubt, like the gifts of Providence, liable to abuse, especially when it is employed to slander private character, or to circulate unfair criticisms on literary subjects: against the first of these the courts of law are some protection, and a free press will counteract the other. It is, however, in the discussion of public measures that its influence is most important. While an individual might be deterred from openly exposing himself to the persecutions of authority, or the malevolence of arbitrary power, he is enabled, without danger, under the shelter of the impersonal character of the press, to denounce the dangerous or flagitious character of measures proposed by the government. But it is not only against the vengeance of governments and statesmen that anonymous writing is a protection It equally shields from the rage of vulgar and unscrupulous opponents the writers who attempt to dispel the illusions which from time to time are produced by the declamatory harangues and usurped ascendency of dangerous agitators; and it is doubtful if freedom could long be sustained in a country where anonymous writing is prohibited.

The law passed by the National Assembly of France during the days of the last republic, by which the writers in public journals were compelled to sign their articles, injuriously affected the independence and dignity of the press, and contributed in some measure to prepare the public mind for the subversion of free institutions. The *Dictionnaire des Anonymes et des Pseudonymes*, by Barbier, is a very valuable work, and throws much light on the history of many anonymous and pseudonymous publications.

ANOPLOTHERIUM, a fossil genus of pachyderm quadruped, discovered by Cuvier in the gypsum of the Paris basin. It had divided hoofs. The two species are *A. commune*, and *A. gracilis.*—See *Ossem. Fossil.* and *Buckland's Bridgewater Treatise.*

ANORTHITE, a crystallised mineral, a silicate of alumina and lime, found principally in the dolomite ejected from Vesuvius. The crystals are vitreous, white, and in doubly oblique prisms.

ANOSMIA (α, priv., and ὀσμή, *odor*), a deprivation of the olfactory sense: a singular affection, and fortunately of rare occurrence. Anosmia has sometimes occurred as a congenital defect; but it more generally has its origin in a diseased state of the *membrana mucosa* itself. The habituation of the olfactories to strong stimuli has been known to produce a similar effect.

ANOTTA, or ARNOTTO, in dyeing, a yellowish red colour, formed from the pellicles or pulp of the seeds of the *Bixa Orellana*, a tree common in South America. It is also called *Terra Orellana*, and *Roucou.*

The manner of making anotta is as follows:—The red seeds, cleared from the pods, are steeped in water for seven or eight days, or longer, till the liquor begins to ferment;

Anquetil. then strongly stirred, stamped with wooden paddles and beaters, to promote the separation of the red skins: this process is repeated several times, till the seeds are left white. The liquor, passed through close cane sieves, is pretty thick, of a deep red colour, and an offensive smell; in boiling, it throws up its colouring matter to the surface in form of scum, which is afterwards boiled down by itself to a due consistence, and made up while soft into balls. The anotta commonly met with among us is moderately hard and dry, of a brown colour on the outside, and a dull red within. It is not easily acted upon by water, and tinges the liquor only of a pale brownish yellow colour. It very readily dissolves in rectified spirit of wine, and communicates a high orange or yellowish red. Hence it is used as an ingredient in varnishes, for giving more or less of an orange cast to the simple yellows. Alkaline salts render it perfectly soluble in boiling water, without altering its colour. Wool or silk boiled in the solution acquires a deep, but not a very durable, orange dye. Its colour is not changed by alum or by acids, any more than by alkalies; but when imbibed in cloth, it is discharged by soap, and destroyed by exposure to the air. It is used to colour cheese.

ANQUETIL, Louis Pierre, a French historian, was born at Paris on the 21st of Jauuary 1723. At the age of 17 he entered the congregation of St Genevieve, where he taught theology and literature with ability and success. He afterwards became director of the academy at Rheims; and in 1759 he was appointed prior of the abbey de la Roe, in Anjou. Soon after this he was sent, in the capacity of director, to the college of Senlis. In 1766 he obtained the curacy or priory of Chateau-Renard, near Montargis, which he exchanged, at the commencement of the Revolution, for the curacy of La Villette, in the neighbourhood of Paris. During the reign of terror he was imprisoned at St Lazare. On the establishment of the National Institute, he was elected a member of the second class, and was soon afterwards employed in the office of the minister for foreign affairs. He died on the 6th of September 1808, in the 86th year of his age. On the evening previous to this event, he is reported to have said to one of his friends, "Come and see a man who is dying full of life."

As an author, M. Anquetil does not stand very high in the ranks of literature. He possessed more industry in research than ability or judgment in execution. His style is censurable in many respects, and he appears to have been almost entirely destitute of the critical discernment and philosophical sagacity which are requisite to form the character of a good historian. The following is a list of his principal works:—

1. *Histoire Civile et Politique de la Ville de Reims.* 1756–57, 3 vols. 12mo. The history is brought no farther down than 1657: a fourth volume should have been added, but it never appeared. Anquetil is said to have written this work in concert with one Felix de la Salle, and it is, perhaps, the best of all his productions. 2. *Almanach de Reims.* 1754, 24mo. 3. *L'Esprit de la Ligue, ou Histoire Politique des Troubles de France pendant les 16 et 17 siècles.* 1767, 3 vols. 12mo. This work has been frequently reprinted. 4. *Intrigue du Cabinet sous Henri IV. et sous Louis XIII. terminée par la Fronde.* 1780, 4 vols. 12mo. 5. *Louis XIV. sa Cour et le Régent.* 1789, 4 vols. 12mo; reprinted in 1794, 5 vols. 12mo. 6. *Vie du Maréchal de Villars, écrite par lui-même, suivie du Journal de la Cour de 1724 à 1734.* Paris, 1787, 4 vols. 12mo; reprinted in 1792. 7. *Précis de l'Histoire Universelle.* 1797, 9 vols. 12mo; reprinted in 1801 and 1807, in 12 vols. 12mo. This work has been translated into English, Spanish, and Italian. 8. *Motifs des Guerres et des Traités de Paix de la France. pendant les règnes de Louis XIV., Louis XV., et Louis XVI.* 1798, 8vo. 9. *Histoire de France depuis les Gaules jusqu'à la fin de la Monarchie.* 1805 et *seqq.* 14 vols. 12mo. This work was composed in haste, and is of no great value. 10. *Notice sur la Vie de M. Anquetil du Perron.* M. Anquetil likewise wrote several papers in the Memoirs of the Institute. (See *Biographie Universelle.*) (J. C.)

Anquetil du Perron. Anquetil du Perron (*Abraham Hyacinthe*), brother of the subject of the preceding article, was born at Paris on the 7th of December 1731. Having distinguished himself as a student at the university of that city, and acquired a considerable knowledge of the Hebrew language, he was invited to Auxerre by M. de Caylus, then the bishop of that diocese. This prelate made him study theology, first at the academy of his diocese, and afterwards at that of Amersfort, near Utrecht; but Anquetil had no desire to embrace the ecclesiastical vocation, and devoted himself with ardour to the study of the different dialects of the Hebrew, and of the Arabic and Persian. Neither the solicitations of M. de Caylus, nor the hopes of rapid preferment, had the power to detain him at Amersfort after he thought he had acquired everything that was to be learnt there. He returned to Paris, where his diligent attendance at the Royal Library, and his ardour in the prosecution of his favourite studies, attracted the attention of the Abbé Sallier, keeper of the manuscripts, who introduced him to the acquaintance of his associates and friends, whose united exertions procured for him a small salary, as student of the oriental languages. He had scarcely received this appointment, when, having accidentally laid his hands on some manuscripts in the *Zend*, he formed the project of a voyage to India, with the view of discovering the works of Zoroaster. At this period an expedition was preparing at the port of L'Orient, which was destined for India. M. du Perron, however, applied in vain, through his protectors, for a passage; and seeing no other means of accomplishing his plan, he enlisted as a common soldier, and set out from Paris, with a knapsack on his back, on the 7th of November 1754. His friends procured his discharge; and the minister, affected by his romantic zeal for science, granted him a free passage, a seat at the captain's table, and a salary, the amount of which was to be fixed by the governor of the French settlements in India. After a passage of nine mouths, Anquetil landed, on the 10th of August 1755, at Pondicherry. Here he remained no longer than was necessary to make himself master of the modern Persian, and then hastened to Chandernagore, where he thought to acquire the Sanscrit. But in this he was deceived; and he was on the point of returning, when a serious complaint threatened his life. He had scarcely escaped from this danger, when war was declared between France and England; Chandernagore was taken; and Anquetil resolved to return to Pondicherry by land. After a journey of one hundred days, in the course of which he encountered many adventures, and suffered many hardships, he arrived at Pondicherry. Here he found one of his brothers who had arrived from France, and embarked with him for Surat; but, with the view of exploring the country, he landed at Mahe, and proceeded on foot. It was at Surat that he succeeded, by perseverance and address in his intercourse with the native priests, in acquiring a sufficient knowledge of the languages to enable him to translate the Dictionary called the *Vedidad-Sade*, and some other works. From thence he proposed going to Benares, to study the languages, antiquities, and sacred laws of the Hindus; but the capture of Pondicherry obliged him to return to France. He accordingly embarked on board an English vessel, and landed at Portsmouth in the month of November 1761. After spending some time in London, and visiting Oxford, he set out for Paris, where he arrived on the 4th of May 1762, without fortune or the desire of acquiring any, but esteeming himself rich in the possession

of one hundred and eighty oriental manuscripts, besides other curiosities. The Abbé Barthelemy, and his other friends, procured for him a pension, with the title and appointments of Interpreter of the oriental languages at the royal library. In 1763 the Academy of the *Belles Lettres* received him among the number of its associates; and from that period he devoted himself to the arrangement and publication of the materials he had collected during his eastern travels. In 1771 he published a work in three volumes 4to, under the title of *Zend-Avesta*, containing collections from the sacred writings of the Persians, among which are fragments of works ascribed to Zoroaster; and he accompanied this work with an account of the life of that sage. This publication must be considered as constituting a very important accession to our stores of oriental literature. A recent historian, and very competent judge, refers to the *Zend-Avesta*, as certainly the most authentic source from which we can derive information regarding the religion and institutions of the great Persian legislator. (Sir John Malcolm's *Hist. of Persia*, vol. i. p. 193, note. To the *Zend-Avesta* M. du Perron prefixed a discourse, in which he treated the university of Oxford, and some of its learned members, with ridicule and disrespect. Mr (afterwards Sir William) Jones replied to these invectives in an anonymous letter, addressed to the author, written in French, with uncommon force and correctness of style, but at the same time with a degree of asperity which could only be justified by the petulance of M. du Perron. In 1778 he published his *Législation Orientale*, in 4to, a work in which he controverts the system of Montesquieu, and endeavours to prove that the nature of oriental despotism has been misrepresented by most authors: that in the empires of Turkey, Persia, and Hindustan, there are codes of written law which equally bind the prince and subject; and that in these three empires the inhabitants possess both movable and immovable property, which they enjoy with perfect security. His *Recherches Historiques et Géographiques sur l'Inde* appeared in 1786, and formed part of Thieffenthaler's *Geography of India*. They were followed in 1789 by his treatise *De la Dignité du Commerce et de l'Etat du Commerçant*. The Revolution seems to have greatly affected him. During that period he abandoned society, shut himself up in his study, and devoted himself entirely to literary seclusion. In 1798 he published *L'Inde en Rapport avec l'Europe*, &c. in 2 vols. 8vo; a work which is more remarkable for its virulent invectives against the English, and for its numerous misrepresentations, than for the information which it conveys, or the soundness of the reflections which it contains. In 1804 he published a Latin translation from the Persian of the *Oupnek'hat* or *Upanischada, i. e.*, Secrets which must not be revealed, in 2 vols. 4to. On the re-organisation of the Institute, M. Anquetil was elected a member, but soon afterwards gave in his resignation. He died at Paris on the 17th of January 1805.

Besides the works we have already enumerated, M. Anquetil read to the academy several memoirs on subjects connected with the history and antiquities of the East. At the time of his death he was engaged in revising a translation of the *Travels of Father Paulin de St Barthelemy in India*, which work was continued by M. Silvestre de Sacy, and published in 1808, in 3 vols. 8vo. He also left behind him a great number of manuscripts, among which his biographers particularly notice the translation of a Latin treatise *on the Church*, by Doctor Legros, in 4 vols. 4to. See *Biographie Universelle; Monthly Review*, vol. 61; Lord Teignmouth's *Life of Sir William Jones*. (J. C.)

ANSÆ, in *Astronomy*, implies the parts of Saturn's ring projecting beyond the disc of the planet. The word is Latin, and properly signifies *handles;* these parts of the ring appearing like handles to the body of the planet.

ANSARIANS, a people of Syria, also called *Ensarians*, properly *Nassaris* and *Ansayri*. The territory occupied by the Ansarians is that chain of mountains which extends from Antakia to the rivulet called *Nahr-el-Kabir*, or the Great River. They are divided into several tribes or sects, among which are distinguished the Shamsia, or adorers of the sun; the Kelbia, or worshippers of the dog; and the Kadmousia, who are said to pay a particular homage to that part in women which corresponds to the priapus. This last tribe appears from Colonel Chesney's account, to be the same as the *Ismaïli*, who implicitly obey their chief Sheikh-al-Hashishin. They are the tribe of *Assassins*, whose principal seat is in the mountains of Persia.—*Expedition to Euphrates and Tigris*, vol. i. p. 543. Their name is now believed to be derived from the narcotic hemp, *Cannabis indica*, which is called in Persia *haschis-sin*, and is employed to intoxicate. The Ansarians have strongholds in the mountains of Tripoli; but their chief seat is in Persia. They are a more vigorous race than most Orientals; browner than the Turks, but fairer than the Arabs. It is said they can muster 40,000 fighting men.

ANSBACH, or ANSPACH, a fortified city of Bavaria, the capital of the circle of Middle Franconia, and of the bailiwick of the same name. It stands on the river Rezat, twenty-five miles south-west of Nuremberg, and in 1846 contained 12,254 inhabitants. It has a royal castle, once the residence of the Margraves of Anspach; a gymnasium, hospital, orphan-asylum, public library, &c., and manufactures of woollen and cotton stuffs, earthenware, tobacco, cutlery, playing-cards, &c.

ANSE, an ancient town of France, in the Lyonnois, on the river Saone. It is the capital of a canton in the department of the Rhone, and formerly bore the title of barony. Pop. 1750. 13½ miles north of Lyons. Long. 4. 44. E. Lat. 45. 55. N.

ANSELM, St, archbishop of Canterbury, in the reigns of William Rufus and Henry I. He was born in the year 1033, at Aosta, a town in Piedmont, at the foot of the Alps. He became a monk in the abbey of Bec in Normandy, of which he was afterwards chosen prior, and then abbot. In the year 1092 he was invited over to England by Hugh earl of Chester; and in the year following was prevailed on to accept the archbishopric of Canterbury. He enjoined celibacy on the clergy, for which he was banished by King Rufus; but recalled by Henry on his coming to the crown. In conformity to Pope Urban's decree, he refused to consecrate such bishops as were invested by the king, denying it to be the royal prerogative: for this he was banished again, till, the pope and king agreeing, he was recalled in 1107. In short, from the day of his consecration to that of his death, he was continually employed in extending the encroachments of the church against the prerogative of the crown; and for that purpose spent much of his time in travelling between England and Rome, for the advice and direction of his Holiness. He may be regarded as having been, besides A'Becket, the only English prelate who strenuously pursued in his ecclesiastical relations that policy distinguished as *ultramontane*. At the council of Bari, in the kingdom of Naples, the pope being puzzled by the arguments of the Greeks against the Holy Ghost's proceeding from the Father, called upon Anselm to answer their objections, which he did with great success. He wrought many miracles, if we may believe the author of his life, both before and after his death, which happened at Canterbury in the 76th year of his age, A.D. 1109, and was canonized in the reign of Henry VII. "His death was that of a saint and a philosopher; his ardour for science glowed upon his death-bed. His disciples were around him weeping and praying; the last holy rites had already enveloped him in the atmosphere of eternity; infi-

nite truths were now to be unfolded to him in clear vision; when at this last moment he cast his thoughts over the obscurities of earthly science, and recalling the efforts he had made to render them more clear, said to his disciples, 'I could have wished before my death to have put down in writing my ideas upon the origin of evil, for I had got some explanations which will now be lost.' A few moments after he passed to where all problems are solved."

Anselm deserves to be remembered as one of the principal revivers of literature, after three centuries of profound ignorance. In a philosophical relation, he may be regarded as the founder of the scholastic metaphysics, and his ontological argument for the existence of Deity entitles him to be considered as one of the acutest of natural theologians. His speculations on that subject are contained in his two treatises entitled *Monologium* and *Proslogium*, composed while he was prior of the Abbey of Bec. The arguments used in the first of these are to be found in the writings of previous philosophers, though not so fully and rigorously developed as is done by Anselm. But the argument contained in the *Proslogium*, originally suggested by St Augustine, and afterwards known as the *Cartesian argument*, is that on which the peculiar fame of Anselm as a metaphysician is founded. It may be briefly expressed thus,—*The human mind possesses the idea of a Being than whom it can conceive none other higher. This perfect Being is in virtue of that very perfection conceived as really existent. Therefore he does so exist.* Anselm sought a general principle for the foundation of all science, a principle such as should unite *logical* and *real* universality, *i. e.*, at once comprehend all other ideas and express a reality conceived as the source of all other realities. This principle he found in the idea of God—of infinite perfection. To deny to this idea a corresponding reality involves a contradiction, for then there must be a higher perfection conceivable, viz., this absolute perfection not merely as possible but as existing, since it is more perfect to exist than to be merely possible. Here Anselm found the principle he was in search of, this idea of God involving both logical and real universality, since on the one hand all other ideas are contained under this, as the lesser is contained in the greater; and on the other, it constitutes the necessary source of all finite existences.

This argument of Anselm seems not to have been generally admitted during the middle ages, and was decisively rejected by such men as Aquinas. It was replied to in his own time by a monk named Gaunilon, in a treatise entitled *Liber pro insipiente adversus Anselmi in Proslogio ratiocinationem*, which contains implicitly all the objections subsequently raised against it as developed by Descartes; the principal and fatal objection being the logical incompetency of deducing the reality of existence from the necessity of thought, of passing from the finite ideas of the human mind to the infinite reality of a Divine existence.

The works of Anslem have been often reprinted. The best edition is that of Father Gerberon, printed at Paris in 1675, in two vols. folio.

ANSELM *of Laon*, a famous theologian, who taught at Paris with great success about the year 1076. With the assistance of his brother Ralph de Laon, he established in his native place a school of philosophy, which became famous throughout Europe. Anselm died in 1117. His interlinear gloss on the Scriptures has frequently been printed.

ANSON, GEORGE, *Lord*, the famous circumnavigator, was the second son of William Anson, Esq. of Shuckborough Manor, Staffordshire, where he was born on the 23d April 1697. Showing an early inclination for the sea, he received a suitable education. The first command he enjoyed was that of the Weasel sloop in 1722; but the most memorable action of his life, and the foundation of his future good fortune, took place on his receiving the command of five ships, a sloop, and two victuallers, equipped to annoy the Spaniards in the South Seas, and to co-operate with Admiral Vernon across the Isthmus of Darien; an expedition the principal object of which failed by the unaccountable delay in the fitting out. He sailed, however, in September 1740; doubled Cape Horn in a dangerous season; lost most of his men by the scurvy; and with only one remaining ship, the Centurion, crossed the Great Pacific Ocean. If no considerable national advantage resulted from this voyage, Commodore Anson made his own fortune, and enriched his surviving companions, by the capture of a rich galleon on her passage from Acapulco to Manilla, with which he returned home round the Cape of Good Hope. If he was lucky in meeting this galleon, he was no less fortunate in escaping a French fleet then cruising in the Channel, by sailing through it during a fog. He arrived at Spithead in June 1744. In a short time after his return he was appointed rear-admiral of the blue, and one of the lords of the admiralty. In April 1745 he was made rear-admiral of the white, and the following year vice-admiral of the blue, at which time he was chosen to represent the borough of Heydon in parliament. In 1747, being on board the Prince George of 90 guns, in company with Admiral Warren and 12 other ships, he intercepted, off Cape Finisterre, a powerful fleet, bound from France to the East and West Indies; when, by his valour and conduct, he again enriched himself and his officers, and at the same time strengthened the British navy, by taking six men of war and four East Indiamen, not one of them escaping. The French admiral, M. Jonquiere, on presenting his sword to the conqueror, said, *Monsieur, vous avez vaincu l'Invincible, et la Gloire vous suit*—"Sir, you have conquered the Invincible, and Glory follows you;" pointing to the ships named the *Invincible* and the *Glory*, which he had taken. For his signal services he was created baron of Soberton in Hants. The same year he was appointed vice-admiral of the red; and, on the death of Sir John Norris, was made vice-admiral of England. In 1748 he was made admiral of the blue: he was afterwards appointed first lord of the admiralty, and was at length made admiral and commander-in-chief of His Majesty's fleet, in which rank he continued, with a very short interval, until his death; and the last service he performed was to convey Queen Charlotte to England. He died in June 1762. No performance ever met with a more favourable reception than the account of Anson's voyage round the world. Though it is printed under the name of his chaplain, it was composed under his lordship's own inspection, and from the materials he himself furnished, by Mr Benjamin Robins.

ANSTEY, CHRISTOPHER, a comic writer, who published in 1766 *The New Bath Guide*, a satirical poem, abounding in coarse humour, and which obtained a degree of popularity almost unparalleled at that period; so much so, indeed, that Dodsley the bookseller, with a liberality scarcely less remarkable, presented the copyright again to the author, in consideration of the profit he had realized by its sale. Anstey was the son of the Rev. C. Anstey, D.D. of Brinkley, and was educated at King's College, Cambridge, where, as a fellow, he continued to reside till the year 1754. Succeeding to some family estates at Trumpington, he made that place his home, and soon afterwards married. He died in 1805, aged eighty-one. His several poems were collected and published in 1808, in 1 vol. 8vo. He was honoured with a cenotaph in "Poet's Corner," in Westminster Abbey, a distinction which has been conferred in more instances than this with too little discrimination.

ANSTRUTHER, EASTER, a royal burgh and parish of Scotland, in the county of Fife, on the north shore of the

Firth of Forth. It possesses an excellent harbour. Population of burgh in 1851, 1161. Ten miles south of St Andrews. Dr Chalmers was a native of this place.

ANSTRUTHER, *Wester*, a parish and small seaport of Scotland, situated close to Easter Anstruther, with which, and the towns of St Andrews, Cupar, Crail, Pittenweem, and Kilrenny, it unites in returning a member to parliament. The parish includes the Isle of May. Population of burgh in 1851, 365. Long. 2. 44. W. Lat. 56. 14. N.

ANT. The history of a tribe of insects so long celebrated for their industry and frugality, and for the display of that sagacity which characterizes some of the higher orders of animals, is peculiarly calculated to occupy the attention of modern naturalists. The ancients, indeed, had often noticed the habits and economy of the ant; but their accounts, at all times deficient in accuracy from the want of precise definitions and logical arrangement of the objects they describe, are in this instance so mixed up with fanciful notions and chimerical doctrines, and so coloured by the vivid imagination and credulity of the narrators, as to have retarded rather than advanced the progress of real knowledge. Aristotle and Pliny report, for instance, that the labours of ants are in a great measure regulated by the phases of the moon; and the latter mentions a species found in the northern parts of India, whose size was said to equal that of the wolves of Egypt, whose colour was the same as that of a cat, and whose occupation in winter consisted in digging up gold from the bowels of the earth; while the inhabitants in the summer robbed them of their treasures, after having decoyed them, by stratagem, from their nests. Great mistakes have prevailed, even in later times, from the circumstance of the larvæ of ants bearing a resemblance to grains of corn, which it was supposed these insects hoarded up as a provision for winter consumption. The form of the eggs and of the larvæ, and the attention paid to them by the ants, were described by Dr King in the 23d number of the *Philosophical Transactions;* but Leeuwenhoeck was the first who distinguished with precision the different forms which the insect assumes in the several stages of its growth. He traced the successive changes from the egg to the larva, the nymph, and the perfect insect. Swammerdam pursued his scrutiny into these successive developments with greater minuteness; and, unrivalled in the art of microscopic dissection, discovered the wonderful encasement of all the parts of the future ant at every preceding stage, and showed that it appears under such different forms only from the nature of its envelopes, each of which, at the proper period, is in its turn cast off. Linnæus (*Memoirs of the Royal Academy of Sciences at Stockholm*, vol. ii.) ascertained some of the leading facts with regard to the distinction between the sexes, and determined that the ants which are furnished with wings are the only individuals that exercise the sexual functions. Several particulars with regard to the economy of the ants were published by Mr Gould, in a book entitled *An Account of English Ants*, of which an abstract is given in the *Philosophical Transactions* for 1747, by the Rev. Dr Miles. The facts are there stated with tolerable correctness; but some errors have been committed by following too closely the analogy with bees. Geoffroy (*Histoire des Insectes qui se trouvent aux Environs de Paris*), though a good naturalist on other topics, is a bad authority on the subject of ants. The most complete series of observations on the natural history of these insects, is that for which we are indebted to the celebrated Swedish entomologist De Geer (*Mémoires pour servir à l'Histoire des Insectes*), an observer on whose fidelity the most implicit reliance may be placed.

In the *Encyclopédie Méthodique*, under the article *Fourmi*, Olivier has drawn up an able statement of all the material facts that had been established by preceding naturalists; without, however, adding any original observations of his own, excepting the description of five or six undescribed species. A full account of the habits of those ants which for a long period infested the island of Martinique, is contained in some of the earlier numbers of the *Journal de Physique* (vols. ix. and x.) The author of these memoirs, M. Barboteau, has given many curious details on this subject, and has cited a number of facts on various authorities; and the account might now be swelled by the reports of subsequent travellers in different parts of the world; but these statements are often made upon slender authority, and are too much tinctured with the marvellous to admit of much credit being attached to them. The narrative given to us by Bonnet in the second volume of his *Observations sur les Insectes*, of the proceedings of a colony of ants which had established itself in the head of a large thistle, and which he transported into his house, is highly interesting; but it elucidates only a few points of their economy, and leaves us to regret that so patient and indefatigable an observer had not bestowed more of his attention to the study of this tribe of insects. In the *Philosophical Transactions* for 1790 we find an interesting memoir on the sugar-ant, a species which, for a period of ten years, committed dreadful ravages in the sugar plantations throughout the whole island of Grenada. The most methodical account of this tribe of insects that has yet appeared is that of Latreille, in his *Histoire Naturelle des Fourmis*, published at Paris in 1802, a work which alone would have secured the reputation of the author as an able and scientific naturalist. His merit is particularly conspicuous in the clearness and accuracy of his descriptions of each species, and the luminous method of arrangement which he has adopted in their classification. He gives an account of one hundred species which he had himself observed, and of twenty-four which he has described from the reports of others: these he distributes into nine natural families, according to the situation and structure of the antennæ, and the form of the abdominal scales. But the work which contains the most copious collection of facts relative to the habits and economy of ants is that of Mr P. Huber of Geneva, entitled *Traité des Mœurs des Fourmis Indigènes*, published in 1810. By means of an apparatus which he contrived so as to admit of his obtaining a view whenever he pleased of the inmost recesses of their habitation, he was enabled to observe what was going on in the interior of the nest, and to investigate with success some of the most important and interesting features of their history. The results of his researches, as they are reported in his work, are highly curious and instructive, and open a wide field of speculation and inquiry to the philosophical entomologist. They have not only elucidated many obscure points with regard to one tribe of insects, but have disclosed some general views of the instincts and faculties of this order of the creation, which are totally new, and must tend, in a considerable degree, to exalt our conceptions of the inexhaustible powers and resources of nature.

Economy and policy of ants.

Having thus pointed out the principal sources of information in this department of entomology, we shall proceed to give an outline of the leading facts that have been ascertained relative to the economy and domestic policy of these remarkable insects.

Functions of the neuters.

In common with many tribes of hymenopterous insects, ants present the remarkable peculiarity of a threefold distinction of sex among the individuals of the same species; a circumstance which is met with in no other order of the animal kingdom, and which appears, as far as observation has extended, to be totallv excluded from the plan

of the vegetable creation. Besides males and females, there exists an apparently intermediate order of *neuters*, which are also denominated labouring or working ants. The neuters, thus exempted from every sexual function, exercise, on the other hand, all the other offices necessary for the existence and welfare of the community to which they belong. It is they who collect supplies of food, who explore the country for this purpose, and seize upon every animal substance, whether living or dead, which they can lay hold of, and transport to their nest. It is they who construct every part of their dwelling-place, who attend to the hatching of the eggs, to the feeding of the larvæ, and to their removal, as occasion may require, to different situations favourable to their growth and development; and who, both as aggressors and as defenders, fight all the battles of the commonwealth, and provide for the safety of their weaker and more passive companions. Thus all the laborious and perilous duties of the state are performed solely by this description of ants, who act the part of helots in these singularly constituted republics of insects. We find, however, on closer examination, that, in all probability, this anomaly in point of sex is more apparent than real; and that, however different in external conformation from the productive females, they nevertheless originally and essentially belong to the same sex. There is every reason to believe that the development of the sexual organs in the former is the consequence of some difference in the circumstances in which the larva is placed during its growth. That such is the case with bees, is now perfectly well established; and the analogy of bees with ants, in many points of physiology, must be admitted as a strong argument in corroboration of this theory. In all the essential features of internal structure, the supposed neuters agree with the female, and differ from the male of the same species. In all hymenopterous insects, which are armed with stings, a difference exists in the two sexes, as to the number of articulations composing the antennæ; those of the female consisting of fewer pieces than those of the male. The accurate observations of Mr Kirby (*Monographia Apum*) have determined that in the bee the antennæ of the male have fifteen articulations, while those of the female and the neuter have only fourteen. In the ant, likewise, we find thirteen articulations in the male, and only twelve in the female; and likewise only twelve in the neuter. In the male ant the abdomen has seven rings, in the female and neuter only six. In the two latter classes the head is broader, and the mandibles very large and powerful compared with those of the male, and are furnished with serrated edges, and a sharp and often hooked point. The external sexual organs of the female and of the neuter are so nearly similar in appearance, that Latreille declares he was unable to perceive the least difference between them. On the other hand, it is to be observed, that in the neuter the principal deviation from the model of the female consists in the absence of wings; a circumstance which, as it regards the organs of locomotion only, is one of subordinate importance in the economy; and their presence may, without difficulty, be conceived to be connected with a certain condition of the sexual organs, as are the horns of the deer, and the beard in the human species. But although of so little consequence in a physiological point of view, it is a circumstance materially affecting their external condition. It dooms them to severe toil and exertion in traversing the ground, and in climbing up the steep paths that may lie in their route; while their more luxurious and favoured associates are fluttering in the spacious realms of air in search of amusement, and wafted to the objects of their gratification on the light breezes of the summer.

Sensitive powers of ants.

Ants appear to be endowed with a greater share of muscular strength than almost any other insect of the same size. Of this we have sufficient proofs in the vivacity of their movements, the incessant toil which many undergo, the great loads which they are seen to carry, often exceeding ten or twelve times their own weight, and the agility which they exert in making their escape from danger. This high degree of irritability is conjoined, apparently, with a corresponding share of the power of sensation; a power which is manifested in their susceptibility to a variety of impressions capable of affecting the organs of sense. They have a quick perception of all changes of temperature, as well as of other conditions of the atmosphere; and are readily and disagreeably affected by moisture. In the perfection of the sense of sight they seem to be nearly on a level with other insects; and the males and females are provided with both the descriptions of eyes peculiar to this class, namely, the composite and the simple eyes. The labouring ants, indeed, who never fly, are frequently destitute of the latter kind; a circumstance which appears to confirm the suspicion that has often been entertained, that the simple eyes are chiefly instrumental in the vision of distant objects. Latreille describes two species of ants, in which he could not discover the least appearance whatsoever of eyes, although he employed a high magnifying power in examining them. One of these (the *Formica cæca*) is a foreign species, inhabiting the forests of Guiana, and of which the history is therefore little known. The other (the *Formica contracta*) is met with in the vicinity of Paris. It always conceals itself during the day under stones, or in obscure recesses, where no light can penetrate; and emerges from its retreat only during the night. It is much less social in its habits than other ants, collecting in groups only of about a dozen individuals, and appears to be far inferior in sagacity to the rest of the tribe.

Ants possess a considerable acuteness of smell, a sense which appears to be useful not only in directing them to their food, but also, as Bonnet first remarked, in enabling them to follow by the scent the track of their companions. If the end of the finger be passed two or three times across the line of their march, so as to brush off the odorous particles with which the ants who had already passed that way may have impregnated the track, those who follow immediately stop on arriving at the place where the experiment has been made, and afterwards direct their course irregularly, till they have passed over the space touched by the finger, when they soon find the path, and proceed with the same confidence as before. Bonnet repeated this experiment frequently, and always with the same result. Latreille has endeavoured to discover the seat of smell, which had long been suspected to reside in the antennæ. He, with this view, deprived several labouring ants of these organs, and replaced them near their nests. When thus mutilated, they wandered to and fro in all directions, as if they were delirious, and utterly unconscious of where they were going. Some of their companions were seen to notice their distress, and, approaching them with apparent compassion, applied their tongues to the bleeding wounds of the sufferers, and anointed them with a liquor which they caused to flow from their own mouths. This trait of sensibility was repeatedly witnessed by Latreille, while he was observing their actions with a magnifying lens.

It is indeed evident that, in all insects, the antennæ are organs of the greatest utility in conveying impressions from external objects. But in the ant, independently of their importance as organs of touch, they appear to be of still greater consequence to the welfare of the individual, and of the community to which it belongs, by being the

chief instruments which enable them to communicate to one another intelligence in which they are mutually interested, and on which they are called upon immediately to act. Mr Huber, to whom we are indebted for a variety of curious observations on this subject, has given the name of *Langage. Antennal* to this species of intercourse. The situation of the antennæ, which are placed in front of the head, their great mobility, their peculiar mechanism, which presents a series of phalanges having great freedom of play, and endowed with exquisite sensibility, conspire to fit them admirably for the function which he assigns to them,—that of producing a variety of different impressions, when applied in different ways to the antennæ or other parts of those ants with which they come in contact. Thus the signal of danger, which consists in the ant which gives the alarm striking its head against the corslet of the other, is propagated from ant to ant with astonishing quickness, throughout the whole society. For a few minutes a general ferment prevails, as if they were deliberating what measures to pursue; but their resolution is soon formed, and they are ready to rush in a body against the enemy. Any small animal that is discovered to have insolently invaded their repose is certain of falling a victim to their resentment, unless he can make a precipitate retreat, which he seldom effects without being covered with the bites of these furious insects. They are not, however, equally jealous of the intrusion of every kind of insect, for woodlice are often found in the interior of the nest, to whom, according to Latreille, they offer no molestation. Ants appear to be incapable of emitting sounds, so as to communicate with one another at a distance; and there is, indeed, no evidence that they possess the sense of hearing. The consideration of the sense of taste naturally comprehends that of their food, to which we shall therefore next proceed.

Their food, and depredations.

Very erroneous opinions were prevalent with regard to the food of ants, which have often been supposed to consume corn, and to do great injury to plants by devouring their roots or stems. The truth is, that they are chiefly carnivorous insects, preying indiscriminately on all the softer parts of animals, and especially the viscera of other insects. These, indeed, they will often attack when alive, and overpower by dint of numbers; either devouring their victim on the spot, or dragging it a prisoner into the interior of the nest. If, however, the game should be too bulky to be easily transported, they make a plentiful meal, and exert, like the bee, a power of disgorging a portion, and of imparting it to their companions at home: and it appears that they are even able to retain at pleasure the nutricious juices unchanged for a considerable time. The rapidity with which they consume, and in fact anatomize, the carcass of any small bird or quadruped that happens to fall in their way, is well known, and furnishes an easy method of obtaining natural skeletons of these animals, by placing their dead bodies in the vicinity of a populous ant-hill. In hot climates, where they multiply to an amazing extent, their voracity and boldness increase with their numbers. Bosman, in his description of Guinea, states that, in one night, they will devour a sheep, leaving it a fine skeleton; while a fowl is for them only the amusement of an hour. In these situations they will venture to attack even living animals of considerable size. Rats and mice often become their victims. The sugar-ants of Grenada cleared every plantation which they visited of rats and other vermin, which they probably effected by attacking their young. Poultry, or other small stock, could not be raised without the greatest difficulty; and the eyes, nose, and other emunctories of the bodies of dying or dead animals, were instantly covered with them. They generally, indeed, begin their attacks on the most sensible parts, which have the finest cuticle; and, accumulating in great numbers about the nostrils, destroy the animal by interrupting respiration. Negroes with sores had difficulty in keeping the ants from assailing them. Their power of destruction keeping pace with their increase of numbers, it is hardly possible to assign limits to either; and the united hosts of this diminutive insect have often become formidable to man himself. A story is related by Prévost, in his *Histoire Générale des Voyages*, of an Italian missionary, resident in Congo, who was awaked by his negroes in great alarm at the house being invaded by an immense army of ants, which poured in like a torrent, and before he could rise had already mounted upon his legs. They covered the floor and passages, forming a stratum of considerable depth. Nothing but fire was capable of arresting their progress. He states that cows have been known to be devoured in their stalls by these daring devastators. Smith, in his *Voyages to Guinea*, reports that at Cape Corse the castle was attacked by legions of ants, who were preceded by thirty or forty, apparently acting as guides. It was at day-break when they made this incursion, entering first by a chapel, on the floor of which some negro servants were lying. Assailed by this new enemy, they fled with precipitation, and gave the alarm to their master, who, on awaking, could hardly recover from his astonishment at beholding the advancing multitude, which extended for a quarter of a mile before him. There was not much time for deliberation; and a happy expedient was adopted of putting a long train of gunpowder across the line of their march, and extending it to their flanks, which had already begun to deploy, and, setting fire to the whole, millions were destroyed at one blow; which so intimidated the rest, that the whole army retreated in disorder, and did not renew the attack.

Descriptions of ant-hills of immense size abound in books of travellers who have visited tropical regions. Mr Campbell (*Account of Travels in South Africa*, published in 1815) observed in the district of Albany, at the Cape, an ant-hill, five feet high, and twelve in circumference. In the forests of Guiana, according to M. Malouet, they attain the height of from fifteen to twenty feet; and, when viewed from a distance on these widely extended savannas, resemble the rude huts of savages; but they contain a race more ferocious than the savage or the tiger himself, and cannot be approached by men without the utmost danger of being devoured. When new settlers, who are clearing the country, meet with any of these in their progress, they must immediately desist from their task, and even abandon the neighbourhood, unless they can speedily destroy the enemy in the very heart of the citadel which protects him, and from which he is able to pour an overwhelming number of combatants. The only method of accomplishing this is to dig a trench all round the ant-hills, and, after having filled it with dry wood and set fire to it on every side, by lighting it quickly in different places, so as to cut off all retreat to the ants, to batter down the edifice with cannon. The ants, thus scattered, soon perish in the flames.

The chief, if not the only vegetable substance which is at all alluring to their appetite, is *sugar*. They not only eat it in substance, but are fond of all fluids that contain it in any quantity,—such as the secretions which exude from many trees, and compose what has been termed the honey-dew; and the saccharine juice which is excreted from the bodies of many of the insects belonging to the genus Aphis. This latter species of food they appear to relish above all others: it resembles honey in its qualities, and is sucked with avidity from the insect which yields it, and which appears in no respect to suffer from the operation. Boissier de Sauvages was the first who noticed this

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singular fact; and Mr P. Huber has ascertained a number of curious circumstances attending it. He conceives that the liquor is given out voluntarily by the aphis, at the solicitation of the ant, who for this purpose strikes it gently and repeatedly with its antennæ, using the same motions as it does when caressing its young; and remarks, that the aphis retains this liquor for a longer time, where the ants are not at hand to receive it. A single aphis may often be seen surrounded by three or four ants who are feeding on the honey, and deriving from it a plentiful meal. It does not appear that the aphis uses any exertion to avoid the ants, who are thus dependent on its bounty; for those provided with wings are quite as passive under these circumstances as the rest. They are, however, of an extremely sluggish nature, and may be seen for days on the same stem, in a state of indolent repose, and averse to use their wings.

A singular observation has been recently made by Professor Savi (the younger) of Pisa, in relation to a species of Italian ant, the nest of which is inhabited by a small grasshopper. These animals do not appear to dwell in the same excavations in a merely casual manner, but they are united by some unaccountable bond of union, which renders the society of the one indispensable to the comfort of the other. The association of the ant and the aphis before alluded to is of a dissimilar nature, being the result of force on the one hand, and of necessity on the other. But, as far as it is possible to judge from the observations hitherto recorded, the cohabitation of the ant and the grasshopper is of a more refined and disinterested kind. It is really impossible at present to account for it on any other principle than that of an affectionate interest in each other's society; for no direct advantage appears to result to either party. On this account Signor Savi has named the grasshopper *gryllus myrmecophilus*.[1] He proved the friendly alliance which subsists between these species, by watching the migratory and other movements of the ants themselves, during which he discovered that they always carried their little grasshoppers along with them. These latter, during fine weather, are seen to sport and play in the vicinity of the ant-nests, into which they immediately betake themselves during any unfavourable change of the air, or the approach of threatened danger.

The cultivation of the sugar-cane in the West Indian islands has often been severely checked by the ravages of ants; but the injury they occasion arises altogether from their undermining the roots, in order to establish their nests where they can be protected from heavy rains, and secured against agitation from violent winds; advantages which the sugar-cane affords them in a very great degree. No part of the plant constitutes their food; and the same is true of those trees among the roots of which they burrow, and of which they speedily occasion the destruction, by preventing the access of moisture.

Ripe fruits are often attacked by ants, probably on account of the sugar they contain; and, for the same reason, the buds of trees are infested with these insects, and often injured by their depredations. There is no evidence that they at any time feed upon corn or other vegetable seed. This point has been well established by Mr Gould; and Bonnet, who kept a colony of ants prisoners in his study, observed, that, however long they had been kept without food, still they never touched the corn that he put before them. Honey and sweetmeats have strong attractions for ants, who, if they once discover their way to a magazine of these dainties, will immediately communicate the tidings to the rest of the society, and, leading them to the spot, a regular path will soon be established, which will continue to be crowded with a train of depredators so long as any thing remains to be pilfered. It is, however, certain, notwithstanding the assertion of Bomare, who compares them to the miser, whose chief pleasure consists in contemplating the riches he has amassed in his coffers, that ants are not in the habit of hoarding provisions for future consumption. They grow torpid when the cold exceeds 27° of Fahrenheit, and in that state require no food; and the aphis affords them sufficient nourishment at other periods of the winter.

Their nests

In building their nests, each species of ant follows its own peculiar mode of construction, and employs different materials for this purpose. Many form them of clay, and particularly the smaller species; one set building up a regular series of apartments in successive stories, often forty in number, with materials which are furnished to them by another set of workers, who are excavating the ground below. The cielings are supported throughout by small pillars in some parts, and by vertical walls in others; while broad arches are in other places raised, in order to protect larger spaces, and to admit of lengthened passages of communication throughout a long extent of apartments. These ants can proceed in the building only at such times as the earth has been softened by rain or dew, and the atmosphere is at the same time sufficiently moist to allow of the materials cohering firmly before they dry. Such are probably the ants which Pliny mentions as working by moonlight. On one occasion, when the ants, under the inspection of Mr Huber, had discontinued their labours on account of too great dryness in the atmosphere, he succeeded in getting them to renew their operations by sprinkling water upon them with a wet brush, in imitation of a natural shower. They carefully close the doors of their habitations every night, in order to prevent the intrusion of other insects; and a few remain on the outside during the night as sentinels, to give alarm in case of danger. Some species of ants collect fragments of leaves, of bark, or of straw, with which they construct more permanent and artificially constructed nests than the former. Others employ nothing but the fine powder which they collect from decayed wood. Some, for greater security, establish themselves under a large stone, or in the crevices of decayed buildings. Several tribes, on the other hand, penetrate into the solid substance of wood, which they scoop out into numerous cells, leaving only intermediate partitions of extreme tenuity, just of the strength sufficient to enable the whole fabric to support itself; while it crumbles into powder when pressed between the fingers.

Fecundation, and growth of their young.

We shall now take a brief review of the principal circumstances relating to the fecundation of the ant, and the evolution and growth of the young. The former is effected very generally during the flight of the females, in which they are accompanied by the males; both appearing to be provided with wings chiefly for this object. A certain number of the females that are impregnated, are also, by the assistance of their wings, enabled to reach distant situations, where they become respectively the founders of new colonies. The males, on the other hand, having fulfilled the office for which nature had destined them, are left to perish on the spot where they descend, being removed from those who formerly administered to them food, and being destitute of the means of procuring subsistence for themselves. Immense swarms of ants are occasionally met with; and some have been recorded of such prodigious density and magnitude as to darken the

[1] *Biblioteca Italiana*, tomo xv. p. 217.

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air like a thick cloud, and to cover the ground to a considerable extent where they settled. Mr Gleditsch describes, in the *History of the Berlin Academy* for 1749, shoals of a small black ant which appeared in Germany, and formed high columns in the air, rising to a vast height, and agitated with a curious intestine motion, somewhat resembling the aurora borealis. A similar flight of ants is spoken of by Mr Acolutte, a clergyman of Breslaw, which resembled columns of smoke, and which fell on the churches and the tops of the houses, where the ants could be gathered by handfuls. In the German *Ephemerides*, Dr Charles Rayger gives an account of a large swarm, which passed over the town of Posen, and was directing its course towards the Danube. The whole town was strewed with ants, so that it was impossible to walk without trampling on thirty or forty at every step. And more recently, Mr Dorthes, in the *Journal de Physique* for 1790, relates the appearance of a similar phenomenon at Montpellier. The shoals moved about in different directions, having a singular intestine motion in each column, and also a general motion of rotation. About sunset they all fell to the ground; and, on examining the ants, they were found tc belong to the *Formica nigra* of Linnæus.

The swarming of ants does not appear to be at all analogous to that of bees: its object seems to be confined to the propagation of the species, and is not the result of any co-operation of numbers, who associate together in search of a new habitation, in which an already populous assemblage may establish themselves. It would appear that the infant colonies consist of very small numbers, and are perhaps wholly the offspring of a common parent, who has migrated alone, or with but a few companions. The greater number of impregnated females alighting in the neighbourhood of the nest, are laid hold of by the labouring ants, who drag them to the nest, where they keep them prisoners till they are ready to deposit their eggs. It is very generally asserted that they also deprive them of their wings; but the later observations of M. Huber disprove that opinion. The impregnated females cast their wings of their own accord. They twist and contort these organs in various directions, till they finally drop off. Such as are unimpregnated have not been observed to perform this singular action. Each female is at this period attended by a numerous retinue of labourers, who treat her with the greatest deference, and are solicitous to anticipate all her wants. Contrary to what happens among bees, many females inhabit the same nest, and live together in the utmost harmony. The eggs, when first deposited, are very small, but become considerably larger before the larva is excluded, being apparently nourished by absorption; for the ants to whose care they are confided are perpetually licking them with their tongues,—a fact which, however curious, is by no means a solitary one in the history of insects. The larva comes forth at the end of a fortnight, and appears in the form of a transparent maggot, with a head and wings, but without any external organs of motion. They are in this state fed by their nurses with a fluid disgorged from their stomachs; and, in the course of their transformation to the state of nympha, and of perfect insect, are still dependent upon their assistance. These affectionate guardians help them to extricate themselves from the web of the cocoon, to unfold the duplicatures of their wings, and supply them with food, till they are capable of procuring it for themselves. The young ant is an exceedingly tender and delicate animal, easily destroyed by any considerable variation of temperature, or by excessive humidity; and great care and attention appear to be required to bring it to maturity: it appears to be the constant business of the ants which remain at home to convey them to different parts of the nest, where the temperature is suited to them; and whenever danger threatens they show the utmost solicitude to remove them to situations of security.

Their sagacity

Very different degrees of sagacity belong to different tribes of ants. Many traits in the history of the larger kinds, as related by Huber, are of so singular a character as to be scarcely credible if we had received them from a less reputable authority, and if we were not already prepared to admit them, from our knowledge of many equally curious circumstances in the economy of bees, which have been established by the concurrent testimony of the most scrupulous observers. Some tribes of ants, according to this naturalist, who are peculiarly fond of the honey which exudes from the aphis, convey many of these insects into their own nests, lodging them near the vegetables on which they feed, but keeping them prisoners within their habitations, and assigning to them distinct apartments in the subterranean recesses of their dwellings. As if conscious of the future advantages they may derive from these insects, they collect their eggs, and superintend their hatching with the same care which they bestow on the eggs of their own species. The aphis lives in perfect harmony with its keepers, who, so far from molesting it, defend it with courage against ants belonging to other nests, who frequently attempt to get possession of them. Occasionally they are lodged by the ants in fortified buildings, which they construct at a distance from the nest, in situations where they are most secure from invasion. The aphis is not the only genus of insect which furnishes this kind of provision to the ant; the kermes and gall-insect are employed occasionally for the same purpose, and are found domesticated in the nests of ants, at the same time that they contain several species of aphis, and from all of which they collect nutriment.

Their wars.

This picture of domestic harmony is strongly contrasted with the scenes of ferocious contention which are occasionally exhibited between the inhabitants of neighbouring nests; nature appearing to have instilled, together with the love of social order, the same passions of rivalry, of ambition, and of revenge, of which we deplore the operation among beings of a higher order. War, the scourge of the human species, exerts its desolating power among the tribes of gregarious insects, and tends to check their otherwise excessive increase of number. The battles which take place between rival colonies of ants are often on a scale of prodigious magnitude: millions of combatants engage on either side with a fury and pertinacity that is truly astonishing. Their weapons of offence are the jaws, which are capable of inflicting a deep bite, and of instilling into the wound a highly acrid liquor; and also, in many species, a sting resembling in situation and structure that of the bee, and likewise containing a venomous juice. The liquor is well known to possess acid properties, and is now found to consist of two acids, and a volatile one, the *formic*, of which the constitution is $C_2 H_2 O_4$. It has been ascertained by the German chemist Döbereiner, that an acid analogous to this animal secretion may be artificially obtained by chemical means. See CHEMISTRY. It is extremely volatile and pungent, and is capable of being thrown out by the ant, when irritated, in considerable quantities. Roux, in the *Journal de Médicine* for 1762, reports a number of experiments which were made by exposing animals to its influence. Frogs were killed by the vapour from an ant's nest in less than five minutes; and persons breathing it, when of a certain intensity, were nearly suffocated, or were seized with fever, followed by an extensive cutaneous eruption, which terminated in desquamation of the cuticle.

Some of the most daring and courageous species, such as that which M. Huber calls the *Amazon-ant*, make it the business of their lives to attack the nests of the weaker species, and succeed, after a desperate conflict, in plundering them of their eggs and larvæ, which they convey to their own nests. These are hatched and reared by ants of the same species as themselves, who may be considered as auxiliaries to the amazons, and who had themselves, at some former period, been kidnapped from their parent nest by the amazons. Thus, a society is formed among different species of insects, to which no parallel exists but in the human race. The amazons live without labour; they are attended, fed, and cherished by the ants which they have procured by this kind of slave-trade, and who take as much care of their offspring as they do of those of their own species. Perfect order is preserved, and the natural instinct of hostility, which in another condition of the society exists between the two tribes, seems in the auxiliaries completely extinguished, by their being educated with the race of their original oppressors.

Ants have numerous enemies among quadrupeds and birds; and some, as the ant-eater, dasypus, and manis or pangolin, together with the tribe of woodpeckers, devour a very large proportion. The *Formica leonis*, or myrmelion, feeds almost wholly on these insects. The bees at the Cape, according to Mr Campbell, frequently drive out the ants from their nests, of which they take possession themselves. Ants are also infested by lice, which, as may well be imagined, are so minute as to be invisible without the assistance of a very high magnifying power. They are stated by Redi, who discovered them, to resemble in shape those of the fowl and the dove.

Mode of destroying ants.

The most effectual mode of destroying ants is to pour boiling water into their nests, which destroys at once both the perfect insects and their eggs and larvæ; so that those who, being from home, had escaped the general catastrophe, finding it impossible to repair the loss, abandon the spot, and disperse. The addition of urine, or of soot, or still better of tobacco, which may be infused in the water, will render it much more efficacious. A decoction of walnut-leaves or lime-water will also generally answer. The night is the best time for applying these remedies, as the ants are then all collected in the nest. Arsenic is exceedingly destructive to ants, and affords another ready mode of getting rid of those that intrude into cupboards or pantries: it may, for this purpose, be mixed with sugar, or kneaded with any kind of provision, and placed in the paths they are observed to frequent. Corrosive sublimate is also highly poisonous to them, and myriads of the sugar-ants at Grenada were destroyed by means of it; and it is stated to have had the effect of rendering the ants so outrageous that they destroyed each other, as could be seen by a magnifying glass, and even, though less distinctly, by the naked eye. It appears also that this effect was produced even when they only came in contact with the poison. The whole island, however, was so overrun with these ants, that the numbers that could be destroyed by these means bore no sensible proportion to the whole; and recourse was had to fire as more applicable to destruction on a larger scale. It was observed that when wood, burnt to the state of charcoal, without flame, and immediately taken from the fire, was laid in their way, they crowded to it in such amazing numbers as soon to extinguish it, though thousands perished by so doing. Holes were therefore dug at proper distances in a cane-piece, and fire made in each of them. Prodigious quantities perished in this way; for those fires, when extinguished, appeared in the shape of mole-hills, from the numbers of dead that were heaped upon them. But as none of the females or young brood were destroyed by this expedient, the ants soon re-appeared in as great numbers as before; and the island would probably have continued subject to this scourge, had it not been for the occurrence of the great hurricane of 1780, which at once cleared all the islands of this dreadful pest, by which the sugar-cane plantations had been threatened with total ruin. (P. M. R.)

For the specific descriptions and systematic arrangement of the different kinds of ants, see ENTOMOLOGY.

Ant-Eater. See MAMMALIA, *Index*.

Ant-Hills are little hillocks of earth which the ants throw up for their habitation and the breeding of their young. They are a very great mischief to dry pastures, not only by wasting so much land as they cover, but by hindering the scythe in mowing the grass, and yielding a poor hungry food, pernicious to cattle. The manner of destroying them is to cut them into four parts from the top, and then dig into them so deep as to take out the core below, so that when the turf is laid down again it may lie somewhat lower than the level of the rest of the land. By this means it will be wetter than the rest of the land, and this will prevent the ants from returning to the same place, which otherwise they would certainly do. The earth that is taken out must be scattered to as great a distance every way as may be, otherwise they will collect it together, and make another hill just by. The proper time for doing this is winter; and if the places be left open, the frost and rains of that time of the year will destroy the rest; but in this case care must be taken that they are covered up early enough in the spring, otherwise they will be less fertile in grass than the other places. In Hertfordshire they use a particular kind of spade for this purpose. It is very sharp, and formed at the top into the shape of a crescent, so that the whole edge makes up more than three fourths of a circle; this cuts in every part, and does the business very quickly and effectually. Others use the same instruments that they do for mole-hills. Human dung is a better remedy than all these, as is proved by experiment; for it will kill great numbers of them, and drive all the rest away, if only a small quantity of it be put into their hills.

ANTACIDS, an appellation given to all medicines proper to correct acid in the stomach. Under the class of antacids come, 1. Absorbents, as chalk, magnesia, carbonates of the alkalies, and pure alkalies; 2. Obtundents, as oils and fats.

ANTÆ. See ARCHITECTURE.

ANTÆOPOLIS, in *Ancient Geography*, the capital of the Nomos Antæopolites, was situated on the right bank of the Nile, in Lat. 27. 11. N. Its site is now occupied by the village of Gau-el-Kebir.

ANTÆUS, in *Fabulous History*, a giant of Libya, son of Neptune and Terra. Designing to build a temple to his father of men's skulls, he slew all he met. In his combat with Hercules he is said to have received strength from the earth every time he was thrown upon it, which Hercules perceiving, lifted him up from the ground and squeezed him to death.

ANTALO, a considerable town of Abyssinia, capital of the flat and fertile district of Enderta, which is dependent on Tigré. It contains not more than 1000 houses, which, with the exception of that destined for the residence of the Ras or sovereign of Tigré, are no better than clusters of huts, with conical thatched roofs.

ANTANACLASIS (ἀντί and ἀνακλάω), literally a reflexion or echo, in *Rhetoric*, a figure which repeats the same word, but in a different sense; as, *dum vivimus, vivamus*.

ANTANAGOGE (ἀντί and ἀναγωγή), in *Rhetoric*, a figure by which, when the accusation of the adversary is unanswerable, we charge him with the same or other crimes.

ANTAR, the hero of an Arabian romance, translated, in

1819, by Hamilton, who was long secretary to the British embassy at Constantinople. Antar was a real personage, a Bedouin Arab, who by his valour and enterprise raised himself to distinction about the close of the fifth century.

ANTARCTIC, in a general sense, denotes something opposite to the northern or arctic pole. Hence antarctic circle is one of the lesser circles of the sphere, and distant only 23° 30′ from the south pole, which is likewise called antarctic for the same reason. See Polar Regions.

ANTARES, or the Scorpion's Heart, in *Astronomy*, the name of a double star, having a small and very close companion. Its R.A. on 1st January 1853, was 16 h. 20 m. 24·020 s.; D. 26° 6′ 3·99″.

ANTEAMBULONES, in *Roman Antiquity*, servants who went before persons of distinction to clear the way before them. They used this formula, *Date locum domino meo*, i. e., Make room, or way, for my master; and whenever this exclamation did not suffice, they made free use of their hands and elbows.

ANTECESSOR, one that goes before. It was an appellation given to those who excelled in any science. Justinian applied it particularly to professors of the civil law; and, in the universities of France, the teachers of law used to take the title of *antecessors* in all their theses.

ANTECURSORES, in the *Roman Armies*, a party of horse detached before, partly to get intelligence, provisions, &c., and partly to choose a proper place to encamp in. These were otherwise called *antecessores*, and by the Greeks πρόδρομοι.

ANTEDILUVIANS, a general name for all mankind who lived before the flood, thus including the whole of the human race from Adam to Noah and his family.

As Moses has not set down the particular time of any transaction before the flood, except only the years of the fathers' ages in which the several descendants of Adam in the line of Seth were begotten, and the length of their several lives, it has been the business of chronologers to endeavour to fix the years of the lives and deaths of those patriarchs, and the distance of time from the Creation to the Deluge. In this there could be little difficulty were there no varieties in the several copies we now have of Moses's writings; which are, the Hebrew, the Samaritan, and the Greek version of the Septuagint; but as these differ very considerably from one another, learned men have been much divided in opinion concerning the chronology of the first ages of the world.

That the reader may the better judge of the variations in the three copies in this period, they are exhibited in the following table, with the addition of those of Josephus as corrected by Dr Wells and Mr Whiston.

A Table of the Years of the Antediluvian Patriarchs.

	Their Ages at their Sons' Birth.				Years they lived after their Sons' Birth.			Length of their Lives.		
	Heb.	Sam.	Sept.	Jos.	Heb.	Sam.	Sept.	Heb.	Sam.	Sept.
Adam	130	130	230	130	800	800	700	930	930	930
Seth	105	105	205	105	807	807	707	912	912	912
Enos	90	90	190	90	815	815	715	905	905	905
Cainan	70	70	170	70	840	840	740	910	910	910
Mahalaleel	65	65	165	65	830	830	730	895	895	895
Jared	162	62	162	62	800	785	800	962	847	962
Enoch	65	65	165	65	300	300	200	365	365	365
Methuselah	187	67	167	187	782	653	802	969	720	969
Lamech	182	53	188	182	595	600	565	777	653	753
Noah was aged at the Flood	600	600	600	600						
To the Flood	1656	1307	2242	1556						

All our authentic information respecting this long and interesting period is contained in 49 verses of Genesis (iv. 16, to vi. 8), more than half of which are occupied with a list of names and ages, invaluable for chronology, but conveying no particulars regarding the primeval state of man. Some additional information, though less direct, may be safely deduced from the history of Noah and the first men *after* the Deluge; for it is very evident that society did not begin afresh after that event; but that, through Noah and his sons, the new families of men were in a condition to inherit, and did inherit, such sciences and arts as existed before the Flood. This enables us to understand how settled and civilised communities were established, and large and magnificent works undertaken, within a few centuries of the Deluge.

The human race probably had before the Deluge whatever knowledge or civilisation their agricultural and pastoral pursuits required. It is remarkable that of the strictly savage or hunting condition of life there is not the slightest trace before the Deluge. After that event, Nimrod, although a hunter (Gen. x. 9), was not a savage, and did not belong to hunting tribes of men. In fact, savagism is not discoverable before the confusion of tongues, and was in all likelihood a degeneracy from a state of cultivation, eventually produced in particular communities by that great social convulsion. That a degree of cultivation was the primitive condition of man, from which savagism in particular quarters was a degeneracy, and that he has not, as too generally has been supposed, worked himself up from an original savage state to his present position, has at least been powerfully argued by Dr Philip Lindsley, and is strongly corroborated by the conclusions of modern ethnographical research; from which we learn that, while it is easy for men to degenerate into savages, no example has been found of savages rising into civilisation but by an impulse from without, administered by a more civilised people; and that, even with such impulse, the *vis inertiæ* of established habits is with difficulty overcome.

All that was peculiar in the circumstances of the antediluvian period was eminently favourable to civilisation. "The *longevity* of the earlier seventeen or twenty centuries of human existence is a theme containing many problems. It may be here referred to for the purpose of indicating the advantages which must necessarily have therefrom accrued to the mechanical arts."

By reason of their length of life, the antediluvians had also more encouragement in protracted undertakings, and stronger inducements to the erection of superior, more costly, more durable, and more capacious edifices and monuments, public and private, than exist at present.

But probably the greatest advantage enjoyed by the antediluvians, and which must have been in the highest degree favourable to their advancement in the arts of life, was the uniformity of language. Nothing could have tended more powerfully to maintain, equalise, and promote whatever advantages were enjoyed, and to prevent any portion of the human race from degenerating into savage life.

The opinion that the old world was acquainted with *astronomy*, is chiefly founded on the ages of Seth and his descendants being particularly set down (Gen. v. 6, *sqq.*), and the precise year, month, and day being stated in which Noah and his family, &c., entered the ark, and made their egress from it (Gen. vii. 11; viii. 13).

That the antediluvians were acquainted with *music* is certain; for it is expressly said that Jubal (while Adam was still alive) became 'the father of those who handle the כִּנּוֹר *kinnur* and the עוּגָב *hugab*.' The *kinnur*, was evidently a stringed instrument resembling a lyre; and the *hugab* was without doubt the pandæan pipe, composed of reeds of different lengths joined together.

With regard to *architecture*, it is a singular and important fact that Cain, when he was driven from his first abode, built a city in the land to which he went, and called it Enoch, after his son. This shows that the descendants of Adam lived in houses and towns from the first, and consequently affords another confirmation of the argument for the original cultivation of the human family.

That they were acquainted with *agriculture*, is obvious from a reference to the case of Noah, who, immediately after the Flood, became a husbandman, and planted a vineyard. He also knew the method of fermenting the juice of the grape; for

it is said that he drank of the wine, which produced inebriation (Gen. ix. 20, 21). This knowledge he doubtless obtained from his progenitors anterior to the destruction of the old world.

It is impossible to speak with any decision respecting the form or forms of government which prevailed before the Deluge. The slight intimations to be found on the subject seem to favour the notion that the particular governments were patriarchal, subject to a general theocratical control—God himself *manifestly* interfering to uphold the good and check the wicked. The right of property was recognised, for Abel and Jabal possessed flocks, and Cain built a city. As ordinances of religion sacrifices certainly existed (Gen. iv. 4), and some think that the sabbath was observed; while some interpret the words, "Then men began to call upon the name of the Lord" (Gen. iv. 26), to signify that public worship then began to be practised.

Marriage, and all the relations springing from it, existed from the beginning (Gen. ii. 23–25); and although polygamy was known among the antediluvians (Gen. iv. 19), it was most probably unlawful; for it must have been obvious that, if more than one wife had been necessary for a man, the Lord would not have confined the first man to one woman. The marriage of the sons of Seth with the daughters of Cain appears to have been prohibited, since the consequence of it was that universal depravity in the family of Seth so forcibly expressed in this short passage, "*All* flesh had corrupted its way upon the earth" (Gen. vii. 11).—*Critica Biblica*, iv. 14–20; Faber's *Horæ Mosaicæ;* P. Lindsley, D.D., *On the Primitive State of Mankind*, in *Am. Bib. Repos.* iv. 277–298; vi. 1–27. See also *Anc. Univ. Hist.* i. 142–201.—*Cyclopædia of Biblical Literature*, by Kitto.

ANTEGO. See Antigua.

ANTEJURAMENTUM, by our ancestors called *juramentum calumniæ*, an oath which anciently both accuser and accused were to take before any trial or purgation. The accuser was to swear that he would prosecute the criminal; and the accused to make oath, on the day he was to undergo the ordeal, that he was innocent of the crime charged against him.

ANTELOPE. See Mammalia, *Index*.

ANTELUCAN, (*ante* and *lux*) denotes what occurs during the night, or before day. We find frequent mention of the antelucan assemblies (*Cœtus antelucani*) of the ancient Christians in times of persecution for religious worship.

ANTEMNAE, a very ancient city of Latium, situated immediately below the confluence of the Anio with the Tiber. Being only three miles from Rome, the inhabitants were soon engaged in war with that rising city, but were vanquished by Romulus, and became a dependency of Rome. No traces of this city remain.

ANTEMURALE, in the *Ancient Military Art*, denotes much the same with what the moderns call an *outwork*.

ANTENATI, in *Modern English History*, is chiefly understood of the subjects of Scotland born before King James the First's accession to the English crown, and alive after it. In relation to these, those who were born after the accession were denominated *Postnati*. The antenati were considered as aliens in England, whereas the postnati claimed the privilege of natural subjects.

ANTENCLEMA, (ἀντὶ and ἔγκλημα) in *Oratory*, is where the whole defence of the accused turns on criminating the accuser. Such is the defence of Orestes, or the oration for Milo: *Occisus est, sed latro: Exsectus, sed raptor.*

ANTENOR, an Athenian sculptor, B.C. 509, celebrated for his bronze statues of Harmodius and Aristogiton. Winkelmann calls him Agenor.

Antenor, a Trojan prince, said to have come into Italy: he expelled the Euganians on the river Po, and built the city of Padua, where his tomb is said to be still extant.

ANTEPILANI, in the *Roman Armies*, the first two lines of troops, consisting of the *Hastati* and *Principes*, in contradistinction to the third line, the *Triarii*, who were called *Pilani*.

ANTEQUERA, a city of Spain, in the province of Malaga. It is situate in a beautiful and fertile valley, covered with olive-trees, around which, in all directions, lofty mountains rise to a great height, which contain valuable quarries of marble of every description. Near it is a saline lake, which supplies the inhabitants of the district with salt for all their culinary purposes. As long as the Moors possessed the kingdom of Granada, this city, from being the point which commands the southern entrance to the plain, was a military post of vast importance, and its possession was perpetually contested by the rival monarchs on both sides of it. An ancient castle still remains, in which are preserved specimens of the various military weapons and accoutrements both of the Moors and the Christians of the fourteenth century. It contains about 17,000 inhabitants, employed in agriculture and in the manufacture of cloth and leather.

ANTEROS, in *Mythology*, one of the two Cupids. They are placed at the foot of the Venus de Medici. Anteros is represented with a heavy and sullen look, agreeably to the poetical description of him, as the cause of love's ceasing. The other was called Eros.

ANTESIGNANI, in the *Roman Armies*, the first line or first body of troops, so called from their being placed before the standards.

ANTESTARI, in *Roman Antiquity*, signifies to bear witness against any one who refused to make his appearance in the Roman courts of judicature on the day appointed, and according to the tenor of his bail. The plaintiff finding the defendant after such a breach of his engagement, was allowed to carry him into court by force, having first asked any of the persons present to bear witness. The person asked to bear witness in this case expressed his consent by turning his right ear, which was instantly taken hold of by the plaintiff; and this was to answer the end of a subpœna. The ear was touched upon this occasion, says Pliny, as being the seat of memory, and therefore the ceremony was a sort of caution to the party to remember his engagement.

ANTHELMINTICS, remedies against intestinal worms.

ANTHEM, a church song performed in cathedral service by choristers, who sung alternately. It was used to denote both psalms and hymns when performed in this manner; but at present, anthem is used in a more confined sense, being applied to certain passages of the Scriptures adapted to a particular solemnity. Anthems were first introduced, in the reformed service of the English church, in the beginning of the reign of Queen Elizabeth.

ANTHEMIS, a genus of plants of the natural order of the Compositæ, to which belong *A. nobilis* or chamomile, *A. tinctoria*, *A. Pyrethrum*.

ANTHEMIUS, a celebrated architect of the time of Justinian, to whom we are indebted for the church of Sta Sophia at Constantinople. He was the first architect who ventured "to suspend a cupola in air." Its diameter of 115 feet, and its perfect preservation, after the lapse of more than thirteen centuries, shows the boldness of the architect's conception, and the scientific skill of its execution. He did not live to see the temple completed, having died in 554: Sta Sophia was not finished until three years thereafter.

ANTHESPHORIA, in *Antiquity*, a Sicilian festival in honour of Persephone. The word is derived from ἄνθος, *flower, and* φέρω, *I carry;* because that goddess was forced away by Pluto when she was gathering flowers in the fields. Yet Festus does not ascribe the feast to Persephone, but says it was thus called because ears of corn were carried on this day to the temples. Anthesphoria seems to be the same thing with the *florifertum* of the Latins, and answers to the harvest-home among us.

ANTHESTERIA, in *Antiquity*, was a feast celebrated by the Athenians in honour of Bacchus. The most natural derivation of the word is from the Greek ἄνθος (*flos*), a

flower, it being the custom at this feast to offer garlands of flowers to Bacchus.

The anthesteria lasted three days, the 11th, 12th, and 13th of the month, each of which had a name suited to the proper office of the day. The first day of the feast was called πιθοιγία, because on this day they tapped the vessels and tasted the wine of the preceding year. The second day they called χόες, from χοῦς, the cup, and seem to have devoted it to drinking; on this they practised the *Ascolia*, with other merriments. The third day they called χύτροι, *kettles:* on this day they boiled all sorts of pulse in kettles; which, however, they were not allowed to taste, as being offered to Hermes.

ANTHESTERION, in *Ancient Chronology*, the eighth month of the Athenian year. It contained 29 days, and answered nearly to our February. It received its name from the festival anthesteria kept in it.

ANTHOLOGION, the title of the service-book used in the Greek church. It is divided into 12 months, containing the offices sung throughout the year, on the festivals of our Saviour, the Virgin, and other remarkable saints.

ANTHOLOGY, a discourse of flowers, or a selection of beautiful passages from various authors. It is also the name given to a collection of epigrams from Greek poets.

ANTHONY, Saint, was born in Egypt in 251, and inherited a large fortune, which he distributed among his neighbours and the poor, retired into solitude, founded a religious order, built many monasteries, and died A.D. 356. Many ridiculous stories are told of his conflicts with the devil, and of his miracles. There are seven epistles extant attributed to him.

St Anthony is sometimes represented with a fire by his side, signifying that he relieves persons from the inflammation called after his name; but always accompanied by a hog, on account of his having been a swine-herd, and curing all disorders in that animal. To do him the greater honour, the Romanists in several places keep at common charges a hog denominated *St Anthony's hog*, for which they have great veneration. Some have St Anthony's picture on the walls of their houses, hoping thereby to be preserved from the plague; and the Italians who do not know the true signification of the fire painted at the side of their saint, concluding that he preserves houses from being burnt, invoke him on such occasions. Painters and poets have made very free with this saint and his followers; the former by the many ludicrous pictures of his temptation, and the latter by various epigrams on his disciples.

Anthony, or *Knights of St Anthony*, a military order instituted by Albert duke of Bavaria, when he designed to make war against the Turks in 1382. The knights wore a collar of gold made in form of a hermit's girdle, from which hung a stick cut like a crutch, with a little bell, as they are represented in St Anthony's pictures.

St Anthony's Fire, a name given to the erysipelas. It was so named from the saint above mentioned, who was especially invoked for its cure.

ANTHOPHORUM, in *Botany*, the columnar process within the calyx, upon which the petals, stamens, and pistil are placed.

ANTHORISMUS (from ἀντί and ὅρος), in *Rhetoric*, a definition of a thing contrary to that given by the adverse party. Thus, if the plaintiff urge, that to take any thing away from another without his knowledge or consent, is a theft; this is called ὅρος, or definition. If the defendant reply, that to take a thing away from another without his knowledge or consent, but with the design to return it to him again, is not theft; this is an ανθορισμος.

ANTHRACITE, or *blind coal*, which burns without flame. Kilkenny coal is of this kind. See Coal.

ANTHRAX, a Greek term, literally signifying a burning coal, used by the ancients to denote a gem, as well as a disease more generally known by the name of *carbuncle*.

ANTHROPOGLOTTUS, among *Zoologists*, an appellation given to such animals as have tongues resembling that of mankind, particularly to the parrot kind.

ANTHROPOLOGY, a discourse upon human nature. It is sometimes applied to designate the speculations and inquiries that have obtained concerning the varieties of the human race. See Man.

ANTHROPOMORPHISM, a term in theology used to denote that figure whereby words derived from *human* objects are employed to express something which relates to the Deity. As a finite being can have no intuitive knowledge of an infinite, so no language of rational creatures can fully express the nature of God and render it comprehensible. All further knowledge of God must be communicated by words used to express ourselves intelligibly concerning human and other terrestrial objects. Such words and phrases have their foundation in a resemblance, which, according to our conceptions, exists between the Deity and mankind.

Anthropomorphitic phrases, generally considered, are such as ascribe to the Deity mixed perfections and human imperfections. These phrases may be divided into three classes, according to which we ascribe to God:—1. Human actions (ἀνθρωποποίησις). 2. Human affections, passions, and sufferings (ἀνθρωποπαθεία). 3. Human form, human organs, human members (ἀνθρωπομόρφισμος).

A rational being, who receives impressions through the senses, can form conceptions of the Deity only by a consideration of his own powers and properties. Anthropomorphitic modes of thought are therefore unavoidable in the religion of mankind; and although they can furnish no other than corporeal or sensible representations of the Deity, they are nevertheless true and just when we guard against transferring to God qualities pertaining to the human senses. It is, for instance, a *proper* expression to assert that God *knows* all things; it is improper, that is, tropical or anthropomorphitic, to say that He *sees* all things. Anthropomorphism is thus a species of *accommodation*, inasmuch as by these representations the Deity, as it were, lowers himself to the comprehension of men. And it is altogether consonant to his wisdom and benevolence in communicating divine revelations to address mankind in language adapted to their inferior capacities. Therefore it is that this figure is called by the Fathers *Divine Economy* (Theodoret, *Dialog.* 2.) and *Condescension* (Gregory of Nazianzus, *Orat.* 1).

ANTHROPOMORPHITES, in *Ecclesiastical History*, a sect of ancient heretics, who, taking every thing spoken of God in Scripture in a literal sense, particularly that passage of Genesis in which it is said *God made man after his own image*, maintained that God had a human shape. They are likewise called *Audeans*. See Audeus. The modern doctrine of the Mormonites is of the same tenor with this.

ANTHROPOMORPHOUS, something that bears the figure or resemblance of a man. Naturalists give instances of anthropomorphous plants, anthropomorphous minerals, &c. These generally come under the class of what are called *lusus naturæ*, or monsters.

ANTHROPOPHAGI (of ἄνθρωπος, *a man*, and φάγειν, *to eat*, Men-Eaters). That there have been, in almost all ages of the world, nations who have followed this barbarous practice, we have abundant testimony.

The Cyclopes, the Læstrygons, and Scylla, are all represented in Homer as *Anthropophagi*, or man-eaters; and the female phantoms, Circe and the Sirens, first bewitched with a show of pleasure, and then destroyed. This, like the other

parts of Homer's poetry, had a foundation in the manners of the times preceding his own. According to Herodotus, among the Essedonian Scythians, when a man's father died, the neighbours brought several beasts, which they killed, mixed up their flesh with that of the deceased, and made a feast. Among the Massagetæ, when any person grew old, they killed him and ate his flesh; but if he died of sickness they buried him, esteeming him unhappy. The same author also assures us that several nations in the Indies killed all their old people and the sick, to feed on their flesh. He adds, that persons in health were sometimes accused of being sick, to afford a pretence for devouring them. According to Sextus Empiricus, the first laws that were made were for the preventing of this barbarous practice, which the Greek writers represent as universal before the time of Orpheus.

Of the practice of anthropophagy in later times, we have the testimonies of all the Romish missionaries who have visited the interior parts of Africa, and even some parts of Asia. When America was discovered, this practice was found to be almost universal, so that several authors have attributed it to a want of other food, or the indolence of the people to seek for it; though others ascribe its origin to a spirit of revenge. It prevailed to an almost incredible extent among the ancient Mexicans, by whom it was associated with their religious ceremonies, and that at a time when they had attained to a comparatively high civilisation and refinement. (See Prescott's *History of the Conquest of Mexico*. Lond. 1843. Vol. i. p. 71–76, &c.)

It appears pretty certain, from recent investigations, that the New Zealanders, inhabiting a country where the larger animals were unknown, were accustomed to devour the bodies of their enemies, and were even epicures in the choice of human flesh. This may have arisen originally from a deficiency of animal food, but cannot be ascribed, as a systematic practice, to the cravings of starvation; for deficiency of all food must have limited population; and that sustenance which fed the victims must have supplied the necessities of their immolators. There can be no doubt that cannibalism has prevailed in some ages and rude societies; but when we reflect how often national hatred has brought this same charge against a detested people, as in the mutual recriminations of the Saracens and Christians of the west, we must receive the accounts of the systematic anthropophagy of various nations, by our early voyagers and travellers, as either gross exaggerations or fictions. (See *Cruise's Voyage; New Zealanders—Lib. Ent. Knowl.*)

Mr Marsden informs us that this horrible custom is practised by the Battas, a people in the island of Sumatra. "They do not eat human flesh," says he, "as a means of satisfying the cravings of nature, owing to a deficiency of other food; nor is it sought after as a gluttonous delicacy, as it would seem among the New Zealanders. The Battas eat it as a species of ceremony; as a mode of showing their detestation of crimes, by an ignominious punishment; and as a horrid indication of revenge and insult to their unfortunate enemies. The objects of this barbarous repast are the prisoners taken in war, and offenders convicted and condemned for capital crimes." This has been confirmed by Raffles.

It may be said, that whether the dead body of an enemy be eaten or buried is a matter perfectly indifferent. But whatever the practice of eating human flesh may be in itself, it certainly is relatively, and in its consequences, most pernicious. It manifestly tends to eradicate a principle which is the chief security of human life, and more frequently restrains the hand of the murderer than the sense of duty r the dread of punishment. Even if this horrid practice originates from hunger, still it must be perpetuated from revenge. Death must lose much of its horror among those who are accustomed to eat the dead; and where there is little horror at the sight of death, there must be less repugnance to murder.

ANTHYPOPHORA, in *Rhetoric*, a figure of speech, being the counterpart of an hypophora. See HYPOPHORA.

ANTI (ἀντί), a Greek preposition, which forms part of many compounded words, meaning against or opposite; sometimes it refers to place, as Antiparos, sometimes to character, as Antichrist.

ANTIARINE, and ANTIARIS. The last is the name of a genus of poisonous plants, to which the noted upas tree of Java belongs. Antiarine is the chemical constituent of this poison, which is obtained from the inspissated juice of the plant in shining whitish crystals, soluble in water. The fables relating to the upas tree may be seen in the notes to *The Botanic Garden*, of Darwin; the real history of the plant in Dr Horsfield's paper in vol. 7, *Batavian Transactions*, and Raffle's *Java*, vol. i. 44. The native name of this tree is *anchar*. It is a *monœcious* plant, growing with a stem to the height of 70 or 80 feet. The bark is whitish, and on being wounded, yields the yellowish-white poisonous juice in large quantity. The stem sends off a few stout branches nearly horizontal, which subdivide into an irregular hemispheric crown. It is only found in deep forests, in fertile soils. The inner bark is fibrous; and when long steeped in water is formed into coarse cloth, like the finer bark of the *Morus papyrifera*, but it is apt to inflame the skin when worn, unless thoroughly beaten and long soaked in water.

ANTIBACCHIUS, in *Ancient Poetry*, a foot consisting of three syllables, the first two long, and the last one short: such is the word āmbīrĕ.

ANTIBES, anciently *Antipolis*, a strongly fortified seaport town of France, in the department of Var, situated on the Mediterranean, 10 miles south-east of Grasse. Its port is good and easy of access, with a lighthouse on a rock at the entrance. Population in 1846, 4515, chiefly engaged in the fishing and curing of sardines and anchovies, and in trading in dried fruits and oil. Lat. 43. 34. 40. N. Long. 7. 7. 50. E.

ANTICHRIST. The meaning attached to this word has been greatly modified by the controversies of various churches and sects. In Scripture, however, and the early Christian writers, it has an application sufficiently distinct from partial interpretations. Antichrist, according to St John, is the ruling spirit of error, the enemy of the truth of the Gospel as it is displayed in the divinity and holiness of Christ. This is the primary meaning of the term, and we are led at once to consider it as the proper title of Satan. But the same apostle speaks of the existence of many antichrists; whence we learn that it is applicable to any being who opposes Christ in the high places of spiritual wickedness. St Paul speaks of "the man of sin" as not yet revealed, and it is supposed by most interpreters that *antichrist* is to be understood as the object alluded to by the apostle; but if we attend strictly to his words, the antichrist of whom he spoke must have been then, and at the time when he was writing, "opposing and exalting himself above all that is called God," although awaiting some distant season for the open display of his power and wickedness. Justin Martyr, in his *Dialogue with Tryphon*, describes him as exercising his wrath against Christians with especial fury in the period immediately preceding the Second Advent. Cyril of Jerusalem represents him as reigning three years and six months preparatory to the entire destruction of his dominion at the second coming of Christ. The same Father says that he will deceive both Jews and Gentiles; the former, by re-

presenting himself as the Messiah; the latter, by his magical arts and incantations. St Chrysostom observes, on the passage in the 2d Epistle to the Thessalonians, that antichrist will not lead men to idolatry, but will rather abolish the worship of false gods as well as that of the true God, commanding the world to worship himself alone as the only Deity.

These views of the early writers, as well as the expressions of Scripture, have been perverted by many men of warm imaginations to the worst purposes of controversy. The effects of general corruption have often been charged upon offices and individuals; and the appellation of *antichrist* as readily applied to them as if it had actually been coupled in Scripture with their name and titles.

ANTICHTHONES (ἀντί and χθών), in *Geography*, an appellation given to the inhabitants of opposite hemispheres.

ANTICIPATION, in *Music*. See MUSIC.

ANTICLIMAX, in *Rhetoric*, a declension in the force or dignity of the ideas at the close of a sentence, as in the following celebrated distich:—

> "The great Dalhousie, he, the god of war,
> *Lieutenant-colonel to the earl of Mar.*"

ANTICOSTI, a barren island in the Gulf of St Lawrence, North America, with an estimated area of 2600 square miles. There are no good harbours on its coast, and the southern shore is low and dangerous. The lighthouse on its south-west point is in Lat. 49. 23. 53. N. Long. 63. 38. 47. W.

ANTICUM, in *Ancient Architecture*, the front door of a house, called also *janua*, and in Greek by the several terms θυρὰ αὔλειος, αὔλεια, αὔλια. The back door in Roman houses was called *posticum*, *postica*, or *posticula*, in Greek παράθυρα or παραθύριον; and Cicero (*Post Red.* 6) uses *pseudothyron* in contradistinction to *janua*. It was accounted ominous to set the left foot on the threshold; hence the steps of a temple were of an uneven number, so that by commencing the ascent with the right foot, the danger would be avoided. (See Vitruvius, iii. 4.) The door of a temple was called *foris* and *valva*, in Greek σανίς, κλισίας, or θύρετρον, these words being generally used in their plural form to denote the two halves of a folding-door. Bivalve doors were also used in private apartments.

ANTICYRA, in *Ancient Geography*, the name of three cities of Greece. (1.) In Phocis, on the Bay of Anticyra, in the Corinthian Gulf. Its modern name is Aspra Spitia, where some remains are still visible. (2.) In Thessaly, on the right bank of the River Sperchius, near its mouth. Both these places were celebrated for their hellebore. (3.) In Locris, on the left side of the entrance to the Corinthian Gulf, and not far from Naupactus.

ANTIDESMA, a genus of plants of the class Diœcia, and order Pentandria.

ANTIDORON, in *Ecclesiastical Writers*, a name given by the Greeks to the consecrated bread, out of which the middle part, marked by the cross, wherein the consecration resides, being taken away by the priest, the remainder is distributed after mass to the poor.

ANTIDOSIS, in *Antiquity*, denotes an exchange of estates, practised by the Greeks on certain occasions with peculiar ceremonies, and first instituted by Solon.

When a person was nominated to an office, the expense of which he was not able to support, he had recourse to the antidosis; that is, he was to seek some other citizen of better substance than himself, who was free from this and other offices; in which case the former was excused. In case the person thus substituted denied himself to be the richer, they were to exchange estates after this manner: the doors of their houses were shut up and sealed, that nothing might be conveyed away; both took an oath to make a faithful discovery of all their effects, except what lay in the silver mines, which by the laws were exempted from all imposts. Accordingly, within three days, a full discovery and exchange of estates was made.

ANTIGALACTIC, a term applied to medicines and other means employed to diminish the secretion of milk.

ANTIGONUS I., one of the captains of Alexander the Great, was the son of Philip a Macedonian nobleman. After Alexander's death, in B.C. 323, a division of the provinces taking place, Pamphylia, Lycia, and Phrygia Major fell to his share. But Perdiccas, well acquainted with his ambitious spirit and great abilities, determined to divest him of his government, and laid plans for his life, by bringing various accusations against him. Antigonus, aware of the danger, retired with his son Demetrius into Greece, where he obtained the favour and protection of Antipater, B.C. 321; and when soon after, on the death of Perdiccas, a new division took place, he was invested not only with the government of the former provinces, but also with that of Susiana. He was likewise intrusted with the command of the Macedonian household troops; and upon Eumenes being declared a public enemy, he received orders to prosecute the war against him with the utmost vigour. At the commencement of this war, Eumenes suffered a total overthrow, and was obliged to retire with only 600 brave followers to a castle situated on an inaccessible rock, where he might rest in safety from all the assaults of Antigonus. In the interval, his friends assembled a new army for his relief, which was routed by Antigonus, who now began to exhibit the great projects of his ambition. Polysperchon succeeding to the tutorship of the young king of Macedon after Antipater's death, Antigonus resolved to set himself up as lord of all Asia. On account of the great power of Eumenes, he greatly desired to gain him over to his interest; but that faithful commander, effecting his escape from the fortress where he was closely blockaded, raised an army, and was appointed the royal general in Asia. The governors in Upper Asia co-operating with him, he succeeded in several engagements against Antigonus; but was at last delivered up to him through treachery, and put to death. Upon this the governor of Upper Asia yielded to Antigonus. Those whom he suspected, he either sacrificed to his resentment or displaced from their offices. Then seizing upon all the treasures at Susa, he directed his march towards Babylon, of which city Seleucus was governor. Seleucus fled to Ptolemy, and entered into a league with him, together with Lysimachus and Cassander, with the intention of giving a check to the exorbitant power of Antigonus, who, notwithstanding this, made a successful attempt upon the provinces of Syria and Phœnicia. But these provinces were soon after recovered by Ptolemy, who defeated his son Demetrius, while he himself was employed in repelling Cassander, who had made rapid progress in Lesser Asia. They were again taken by Antigonus, who, flushed with success, planned an expedition against the Nabathæan Arabs dwelling in the deserts adjacent to Judæa; but on the first enterprise against the town of Petra, his general Athenæus, with almost all his troops, were cut to pieces by the Arabs. Antigonus then sent his son against them, who returned after forcing them to reasonable terms. Demetrius then expelled Seleucus from Babylon; and success attending his arms wherever he went, the confederates were obliged to make a treaty with Antigonus, in which it was stipulated that he should remain in possession of all Asia, but that the Greek cities should continue in possession of their liberty. This agreement was soon violated, under the pretence that garrisons had been placed in some of these cities by Antigonus. At first Ptolemy made a successful descent into Lesser Asia, and on several of the islands of the Archipelago; but he was at length defeated in a sea-fight by the successful arms of Demetrius, who also took the island of Cyprus, with many prisoners.

On this victory Antigonus was so elated that he assumed the title of king, and bestowed the same upon his son; and from that time, B.C. 306, his reign in Asia, and that of Ptolemy in Egypt, and of the other captains of Alexander in their respective governments, properly commence.

Irritated at the hostile conduct of Ptolemy, Antigonus prepared a numerous army and a formidable fleet; and having taken the command of the army, he gave that of the fleet to Demetrius, and hastened to attack Ptolemy in his own dominions. After enduring the severest hardships, they met in the vicinity of Mount Casius; but Ptolemy acted with such valour and address that Antigonus could gain no advantage over him; and after several fruitless attempts, he abandoned the undertaking. Demetrius attempted the reduction of Rhodes; but meeting with obstinate resistance, he was obliged to make a treaty upon the best terms that he could, having been called to join Antigonus against Cassander, who at this time had formed a confederacy with Seleucus and Lysimachus. When Demetrius united his forces with those of Antigonus, they advanced to Phrygia, and having met the enemy at Ipsus, a decisive battle was fought, in which Antigonus fell in the 81st year of his age, B.C. 301.

ANTIGONUS II., *Gonatas*, son of Demetrius Poliorcetes, was the grandson of the former Antigonus. His character was eminently distinguished by humanity and mildness of disposition. When he besieged Thebes under the command of his father, he strongly remonstrated against the loss of so many lives for such an insignificant object. Filial affection was so powerful in his mind, that when his father was taken prisoner by Seleucus, he generously offered himself in his stead; and being rejected, he wore deep mourning, and refrained from all festivals and amusements during his father's imprisonment. By the death of his father, in B.C. 283, he became master of all the European dominions of Demetrius, together with the kingdom of Macedon, and various other cities in Greece. The Gauls invading his country, he defeated and expelled them; but was soon after routed by Pyrrhus, king of Epirus. Some time after, however, Pyrrhus was slain at Argos; and when his head was brought to Antigonus by his son, he expressed the highest displeasure, and throwing his robe over it, gave orders to search for the body, and to inter it with all funeral honours.

In the evening of his reign he so cultivated the arts of peace, that he secured the affections of his subjects both to himself and his descendants. The taking of the citadel of Corinth by intrigue was the meanest action of his reign; but he improved that event in maintaining the freedom of the smaller states of Greece, and in increasing his own dominions. The Achæans, and Aratus their famous chief, vigorously opposed his measures, and at length recovered Corinth; but Antigonus was so inclined to peace, that notwithstanding this event, he pursued his wonted plan, and left his kingdom in peace, about the 80th year of his life and the 44th of his reign, B.C. 239.

ANTIGRAPHUS, a name used by writers in the middle ages for a secretary or chancellor. The antigraphus is sometimes called *archigraphus*. The term is also applied by ecclesiastical writers to an abbreviator of the papal letters; in which sense the word is used by Pope Gregory the Great in his register.

ANTIGUA, one of the Antilles or Caribbee Islands, situated 20 leagues east of St Christophers, in Long. 61. 45. W. and Lat. 17. 6. N. It is about 50 miles in circumference, and is reckoned the largest of the British Leeward Islands. This island having no rivers, and but few springs, or such as are brackish, the inhabitants are obliged to preserve the rain-water in cisterns. The air here is not so wholesome as in the neighbouring islands, and it is more subject to hurricanes; but it has excellent harbours, particularly English Harbour, which is capable of receiving the largest man-of-war in the navy. The principal trade, however, is carried on in the harbour of St John's the capital, situated in the north-west part of the island, and which has water sufficiently deep for merchant vessels. The island contains an area of 108 British square miles, equal to 69,120 acres, of which about 34,000 are appropriated to the growth of sugar, including pasture grounds. The other staples are cotton, ginger, and tobacco.

The first attempt to establish a settlement in Antigua was made by Sir Thomas Warner, but it did not succeed. It was afterwards granted by Charles II. to Lord Willoughby, who in 1632 settled a colony upon it. In 1850 the population was 37,357, of whom only about 2000 were whites. The estimated value of the imports in 1851 was L.198,425 sterling; of the exports, L.219,239, being an increase over the preceding year of L.34,802, and L.87,357 respectively. In 1851 the ordinary revenue was L.21,888, and the expenditure L.21,193. The island is under a governor, council, and assembly.

ANTILEGOMENA (ἀντιλεγόμενα, *contradicted* or *disputed*), an epithet applied by the early Christian writers to denote those books of the New Testament which, although sometimes publicly read in the churches, were not for a considerable time admitted to be genuine, or received into the canon of Scripture. These books are so denominated in contradistinction to the *Homologoumena*, or universally acknowledged writings. The following is a catalogue of the *Antilegomena*:—*The Second Epistle of St Peter; the Epistle of St James; the Epistle of St Jude; the Second and Third Epistles of St John; the Apocalypse*, or *Revelation of St John; the Epistle to the Hebrews.*

The earliest notice which we have of this distinction is that contained in the *Ecclesiastical History* of Eusebius, who flourished A.D. 270–340.

ANTILLES, the French name for the Caribbee Islands.

ANTILOGARITHM, the complement of the logarithm of a sine, tangent, or secant; or the difference of that logarithm from the logarithm of 90 degrees.

ANTILOGY, in *Literature*, an inconsistency between two or more passages of the same book.

ANTILOIMICS (ἀντί and λοιμός, *pestilence*), remedies against infection, of which the most efficacious is chlorine, the next in power the vapour of nitric acid, and thirdly, that of the muriatic acid.

ANTIMENSIUM, a kind of consecrated table-cloth, occasionally used in places where there is no proper altar.

ANTIMENSIUM, in the Greek church, answers to the *altare portabile*, or portable altar, in the Latin church. They are both only of late invention, though Habertus would have them as old as St Basil. But Durant and Bona do not pretend to find them in any author before the time of Bede and Charlemagne.—*Antimensia* is also applied to other tables used in offices of religion, besides those whereon the eucharist is administered; such, *e. g.*, are those whereon the host is exposed, &c.

ANTIMERIA, in *Grammar*, a figure whereby one part of speech is used for another; e. g., *velle suum cuique est*, for *voluntas sua cuique est*; also *populus late rex*, for *populus late regnans*. In a more restricted sense, it denotes a figure where the noun is repeated instead of the pronoun. This figure is frequent in the Hebrew, and is sometimes retained in our version of the Old Testament: e. g., *Hear my voice, ye wives of Lamech*,—for *my wives*. Gen. iv. 23.

ANTIMONY, a metal very rarely found pure in nature, but generally as a sulphuret, to which indeed the name of Stibium, or Στιμμι, was applied by the ancients; and the sulphuret, it is said, from a preparation of it having proved fatal to the monks of a German convent, afterwards ob-

Antinomians ‖ Antinous.

tained the name of antimony—*quasi, anti monachos.* Whether this be true or not, this name soon became general for the sulphuret, and is now applied to the pure metal.

Antimony has a white colour, with nearly the lustre of silver when fresh; but it tarnishes slowly when freely exposed. Its specific gravity is only 6·7, and it melts at 810° F. On cooling, it shows a tendency to crystallise, and assumes a foliated texture. When moderately heated in the open air, it catches fire, and burns with a bright bluish-white flame. It is brittle, and easily pounded.

It unites with oxygen into a white oxide, now generally employed for obtaining antimonial medicines, especially emetic tartar, which is a tartrate of antimony and potash. The metal forms several compounds with sulphur; the most important of which is the black sulphuret, the ore from which antimony is always obtained for the arts. This substance, as we have said, was the ancient Stibium, and is the material applied ages ago by the women of Eastern countries to give increased lustre to their eyes by darkening the eyelashes. The *paint* said in the Holy Scriptures to have been used by Jezebel, seems to have been this substance; for St Jerome, who knew the manners of Eastern women, has, in the Vulgate, rendered the passage "*oculos ejus posuit stibio.*" All our antimonial preparations were formerly made directly from the sulphuret; and it was used to form alloys before its true nature was understood. The pure metal was *then* termed regulus of antimony, and under this name it is mentioned in the *Currus Antimonii Triumphalis* of Basil Valentinus, a German monk and alchemist.

Alloys of antimony with other metals are of value. It is added to gold in ornamental work, to give variety of colour; it is added to bell-metal to increase the sonorous quality of the compound; it is alloyed with lead and tin to give hardness and solidity to type-metal; a small addition of it to 11 parts of tin and 4 of copper, improves the quality of specula for telescopes, and enables the compound to receive a higher polish. See CHEMISTRY. (T. S. T.)

ANTINOMIANS, in *Ecclesiastical History*, certain heretics who maintain that the law is of no use or obligation under the gospel dispensation, or who hold doctrines that clearly supersede the necessity of good works and a virtuous life. The Antinomians took their origin from John Agricola about the year 1538, who taught that the law is nowise necessary under the gospel; that good works do not promote our salvation, nor ill ones hinder it; that repentance is not to be preached from the Decalogue, but only from the Gospel.

This sect sprung up in England during the protectorate of Oliver Cromwell, and extended their system of libertinism much further than Agricola. Some of their teachers expressly maintained, that as the elect cannot fall from grace, nor forfeit the divine favour, the wicked actions they commit are not really violations of the Divine law; and that, consequently, they have no occasion either to confess their sins, or break them off by repentance.

The doctrine of Agricola was in itself obscure, and perhaps represented as worse than it really was by Luther, who wrote with acrimony against him, and first styled him and his followers *Antinomians.* Agricola stood on his own defence, and complained that opinions were imputed to him which he did not hold. Nicholas Amsdorf fell under the same odious name and imputation, and seems to have been treated more unfairly than even Agricola himself.

ANTINOUS, a beautiful Bithynian youth, celebrated as the favourite of the Emperor Hadrian, who paid the most extravagant honours to his memory. Antinous was drowned in the Nile, and near the spot where he perished, on the site of the ancient Besa, the emperor founded a city which he named *Antinoopolis.* At Mantinēa in Arcadia a temple was erected to Antinous, in which he was worshipped as a deity, and there, and at Bithynium, his birthplace, Hadrian instituted annual sacrifices and quinquennial games, called *Antinoeia.* A constellation into which his soul was supposed to have passed still bears his name.

Antioch.

The death of Antinous (about the year 122) constitutes an era in the history of art, from the stimulus given to sculpture by the demand for busts and statues commemorative of his extraordinary beauty. Many of these are extant. They are supposed to be of Grecian execution, though wrought in Italian marble. (Levezow, *Ueber den Antinous*, &c.; Berlin, 1801.)

ANTIOCH, a city of Syria, in Asia, on the River Orontes, in Long. 36. 10. E. Lat. 36. 11. N. It was built by Seleucus Nicator, founder of the Syro-Macedonian empire, who made it his capital. It stood on the above-mentioned river, about 20 miles from the place where it falls into the Mediterranean, being equally distant from Constantinople and Alexandria in Egypt, that is, about 700 miles from each. Seleucus called it *Antioch*, from his father's name according to some, or, according to others, from that of his son. He built in all sixteen cities bearing the same name, of which one was situated in Pisidia. But that situated on the Orontes by far eclipsed not only all the others of this name, but all the cities built by Seleucus; and is probably that where the name of Christians was first given to the followers of Jesus Christ. Antigonus, not long before, had founded a city in that neighbourhood, which from his own name he had called Antigonia, and designed it for the capital of his empire; but it was razed to the ground by Seleucus, who employed the materials in building his metropolis, and also transplanted the inhabitants thither.

Antioch was afterwards known by the name of Tetrapolis, being divided as it were into four cities, each surrounded with its proper wall, besides a common one which inclosed the whole. The first of these cities was built by Seleucus Nicator, as already mentioned; the second by those who flocked thither on its being made the capital of the Syro-Macedonian empire; the third by Seleucus Callinicus; and the fourth by Antiochus Epiphanes. About four or five miles distant stood a place called Daphne, which was nevertheless reckoned a suburb of Antioch. Here Seleucus planted a grove, and in the middle of it built a temple, which he consecrated to Apollo and Diana, making the whole an asylum. To this place the inhabitants of Antioch resorted to indulge in amusements and impure pleasures, by which it became at last so infamous, that "to live after the manner of Daphne" was used as a proverb to express the most voluptuous and dissolute life.

Though Antioch continued to be, as Pliny calls it, the queen of the East, for near 600 years, yet scarcely any city mentioned in history has undergone such calamities, both from the attacks of its enemies, and the destructive shocks of earthquakes. The first disaster mentioned in history which befell the Antiochians happened about 145 years before Christ. Being at that time very much disaffected to the person and government of Demetrius their king, they were continually raising tumults and seditions. Wearied with their turbulence, he at last solicited assistance from the Jews, and was furnished by Jonathan, one of the Maccabees, with 3000 men. With this reinforcement believing himself sufficiently strong to reduce the mutineers by force, he ordered them immediately to deliver up their arms. This unexpected order caused a great uproar in the city. The inhabitants ran to arms and invested the king's palace, to the number of 120,000, with a design to put him to death. All the Jews hastened to his relief, fell upon the rebels, killed 100,000 of them, and set fire to the city. On the destruction of the Syrian empire by the Romans, Antioch submitted to them, and continued for a long time under

their dominion. About the year 115, in the reign of the Emperor Trajan, it was almost entirely ruined by one of the most dreadful earthquakes mentioned in history. Trajan himself happened to be there at the time, on his return from an expedition against the Parthians; so that the city was then full of troops and strangers from all quarters, either out of curiosity or upon business and embassies. The calamity was consequently felt in almost every province of the Roman empire. The earthquake was preceded by violent claps of thunder, unusual winds, and a dreadful noise under ground. Tho shock was so terrible, that great numbers of houses were overturned, and others rocked to and fro like a ship at sea. Those who happened to be in their houses were for the most part buried under their ruins; those who were walking in the streets or in the squares, were dashed to the ground by the violence of the shock, and most of them either killed or dangerously wounded. The earthquake continued, with small intermission, for several days and nights. Trajan was much hurt, but escaped through a window. Being an eyewitness of this terrible calamity, he would very probably contribute largely towards the re-establishment of Antioch in its ancient splendour. Its good fortune, however, did not continue long; for in 155 it was almost entirely destroyed by a fire, when it was again restored by Antoninus Pius.

When the Roman empire began to decline, Antioch became a source of contention between it and the Eastern nations; and accordingly, on the breaking out of a Persian war, it was almost always sure to suffer. In 242 it was taken and plundered by Sapor; and though he was defeated by Gordian, it underwent the same misfortune in the time of Valerian, about 18 years after; and subsequently to the defeat and captivity of Valerian, it was a third time taken by the Persian monarch, who not only plundered it, but levelled all the public buildings with the ground. The Persians, however, being soon driven out, this unfortunate city continued free from any remarkable calamity till about the time of the division of the Roman empire by Constantine in 331. It was then afflicted with so terrible a famine, that a bushel of wheat was sold for 400 pieces of silver. During this grievous distress, Constantine sent to the bishop 30,000 bushels of corn, besides an immense quantity of all kinds of provisions, to be distributed among the ecclesiastics, widows, orphans, &c. In the year 347 Constantius II. caused a harbour to be made at Seleucia, for the conveniency of Antioch. This was effected at great expense; the mouth of the Orontes, where the port was made, being full of sands and rocks. When the Emperor Julian set out on his expedition against the Persians, he made a long stay at Antioch, which then suffered severely from famine. In 381, in the reign of Theodosius the Great, Antioch was again visited by a famine, accompanied with a grievous plague. In 387 Theodosius, finding his exchequer quite drained, and being obliged to be at an extraordinary expense in celebrating the fifth year of the reign of his son Arcadius, and the tenth of his own, an extraordinary tax was laid upon all the people in the empire. Most of the cities submitted willingly to this; but the people of Antioch assailed their governor, broke some of the emperor's statues, and dragged others through the city, uttering the most injurious and abusive expressions against him and his whole family. They were dispersed by a body of archers, and the governor proceeded against the offenders with the utmost cruelty, exposing some to wild beasts in the theatre, and burning others alive. Many fled from the city and never returned. On hearing the news of the tumult, Theodosius was so much enraged that he commanded the city to be destroyed, and its inhabitants to be put to the sword without distinction; but this order was revoked before it could be put into execution, and he contented himself with inflicting severe punishments on individuals. In the year 458 Antioch was again almost entirely ruined by an earthquake, which happened on the 14th of September; scarcely a single house being left standing in the most beautiful quarter of the city. It experienced a similar misfortune in 526, during the reign of the Emperor Justin; and twelve years after, when taken by Chosroes king of Persia, that insulting and haughty monarch gave it up to his soldiers, who put all they met to the sword. The king himself seized on all the gold and silver vessels belonging to the great church, and caused all the valuable statues, pictures, &c., to be taken down and conveyed to Persia, while his soldiers carried off every thing else. The city being completely plundered, he ordered his men to set fire to it; and this was done so effectually, that none of the buildings even without the walls escaped. Such of the inhabitants as escaped slaughter were carried into Persia and sold as slaves. The city, however, was again restored, but in a short time underwent its usual fate, being almost entirely destroyed by an earthquake in 587, by which 30,000 persons lost their lives. In 634 it fell into the hands of the Saracens, who kept possession of it till the year 975, when it was surprised by one Burtzas, and again annexed to the Roman empire. The Romans continued masters of it for some time, till the civil dissensions in the empire gave the Turks an opportunity of mastering it, as well as the whole kingdom of Syria. From them it was again taken by the crusaders in 1098. In 1268 it was again taken by Bibaris, sultan of Egypt, who put a final period to its glory.

The ancient walls of Antioch are of surprising solidity; and are carried along the face of the precipitous hill on which the acropolis stood. They inclose a space of nearly seven miles in circumference, forming an irregular parallelogram. The modern city, according to Chesney, covers but a small part of the ancient Antioch, the remainder being occupied with mulberry groves, vineyards, and fruit gardens.

In 1835 it contained 5600 inhabitants, and 6000 Egyptian soldiers, when it was the headquarters of Ibrahim Pasha. It has never recovered the great earthquake of 1822.

Antioch, called by the Arabs *Antakiyah*, is now a ruinous town, whose houses, built with mud and straw, and narrow and miry streets, exhibit every appearance of misery and wretchedness. These houses are situated on the southern bank of the Orontes, at the extremity of an old decayed bridge: they are covered to the south by a mountain, upon the slope of which is a wall built by the crusaders. The distance between the present town and this mountain may be about 400 yards, which space is occupied by gardens and heaps of rubbish, but it presents nothing interesting. Antioch was better calculated than Aleppo to be the emporium of the Europeans. By clearing the mouth of the Orontes, which is six leagues lower down, boats might have been towed up that river, though they could not have sailed up, as Pococke has asserted, its current being too rapid. The natives, who never knew the name Orontes, call it, on account of the swiftness of its stream, *El Aasi*, that is, the rebel. Its breadth at Antioch is about forty paces. Seven leagues above that town it passes by a lake abounding in fish, and especially in eels. A great quantity of these are salted every year, but not sufficient for the numerous fasts of the Greek Christians. The plain of Antioch, though the soil of it is excellent, is uncultivated and abandoned to the Turkomans; but the hills on the side of the Orontes, particularly opposite Serkin, abound in plantations of figs and olives, vines and mulberry trees. Seleucus Nicator, who founded Antioch, built also at the mouth of the Orontes, on the northern bank, a large and well-fortified city, which bore his name, but of which at present not a single habitation remains; nothing is to be seen but heaps of rubbish,

and works in the adjacent rock, which prove that this was once a place of very considerable importance. In the sea also may be perceived the traces of two piers, which are indications of an ancient port, now choked up. The inhabitants of the country go thither to fish, and call the place *Souaidia*. Antioch is situated in Long. 37. 5. E. and Lat. 36. 20. N. (D. B—N.)

ANTIOCH, in *Pisidia*. The ruins of this city, of great magnificence, were discovered by Arundel, in 1833, about a mile from Yalobatch, and are in Lat. 38. 18. N. Long. 31. 23. E.—*Researches in Asia Minor.*

It was to this Antioch that Paul and Barnabas came on leaving Perga; and after preaching here, a commotion being raised against them by the Jewish inhabitants, "they shook off the dust of their feet." The city is said by Strabo to be in Phrygia, *near* Pisidia. The remains consist of an aqueduct, a theatre, foundations of temples, and innumerable fragments of fine cornices and columns.

ANTIOCH *ad Taurum*, now Aïntab; which see.

ANTIOCHIAN SECT or ACADEMY, a name given to what was called the fifth academy, from its being founded by Antiochus, a philosopher contemporary with Cicero. The Antiochian academy succeeded the Philonian. As to doctrine, the philosophers of this sect appear to have restored that of the ancient academy, except in the article of the criterion of truth. Antiochus was really a Stoic, and only nominally an Academic.

ANTIOCHIAN Epocha, a method of computing time from the proclamation of liberty granted to the city of Antioch about the time of the battle of Pharsalia.

ANTIOCHUS I., SOTER, king of Syria, was the son of Seleucus I., and began to reign in B.C. 280. He fell violently in love with his step-mother Stratonice, who was resigned to him by his father, on the discovery that this was the cause of the distemper which threatened his life. He was slain in battle against the Gauls in B.C. 261.

The most compact and unbroken account of the kings of this dynasty is to be found in Appian's book, *De Rebus Syriacis*, at the end. The dates of the following table are taken from Clinton's *Fasti Hellenici*, vol. iii. Appendix, ch. iii.:—

1. Seleucus Nicator, B.C. 312–280.
2. Antiochus Soter, his son, 280–261.
3. Antiochus Theus, his son, 261–247.
4. Seleucus Callinicus, his son, 247–226.
5. (Alexander, or) Seleucus Ceraunus, his son, 226–223.
6. Antiochus the Great, his brother, 223–187.
7. Seleucus Philopator, his son, 187–176.
8. Antiochus Epiphanes, his brother, 176–164.
9. Antiochus Eupator, his son (a minor), 164–162.
10. Demetrius Soter, son of Seleucus Philopator, 162–150.
11. Alexander Balas, *a usurper*, who pretended to be son of Antiochus Epiphanes, and was acknowledged by the Romans, 152–146. See ALEXANDER BALAS.

[12. Antiochus Theus, or Alexander (a minor), son of the preceding. He was murdered by the usurper Trypho, who contested the kingdom till 140.]

12. Demetrius Nicator, son of Demetrius Soter, reigned 146–141, when he was captured by the Parthians.
13. Antiochus Sidetes, his brother, 141–128.

Kings of the same family reigned in Antioch until Pompey reduced Syria to the form of a Roman province, B.C. 63.

ANTIOCHUS *of Ascalon*, a celebrated philosopher, the disciple of Philo of Larissa, the master of Cicero, and the friend of Lucullus and Brutus. He was founder of a fifth academy. See ANTIOCHIAN SECT.

ANTIOPE, in *Fabulous History*, the wife of Lycus, king of Thebes, who being deflowered by Zeus in the form of a Satyr, brought forth Amphion and Zethus. Another Antiope was queen of the Amazons, and, with the assistance of the Scythians, invaded the Athenians, and was vanquished by Theseus.

ANTIPÆDOBAPTISTS (derived from ἀντί, *against*, παῖς, παιδός, *child*, and βαπτίζω, *I baptize*), is a distinguishing denomination given to those who object to the baptism of infants. See BAPTISTS.

ANTIPAROS, an island in the Archipelago, opposite to Paros, from which it is separated by a strait about seven miles wide. It is the *Oleares* or *Oliaros* mentioned by Strabo, Pliny, Virgil, Ovid, &c.; and was, according to Heraclides Ponticus, as quoted by Stephanus, first peopled by a Phœnician colony from Sidon. According to Tournefort, it is about 16 miles in circumference.

This island is remarkable for a subterraneous cavern or grotto, accounted one of the greatest natural curiosities in the world. It is 300 fathoms below the surface of the earth, and appears to be about 40 fathoms high and 50 wide, penetrating far into the bosom of the island. It is full of large and beautiful stalactites. There have been many descriptions of this celebrated grotto, of which that by Tournefort is supposed to be very complete and exact.—*Relation d'un Voyage du Levant.*

ANTIPAS HEROD, or HEROD-ANTIPAS, the son of Herod the Great, by one of his wives called Malthake, a native of Jerusalem. Herod the Great, in his first will, appointed Antipas his successor in the kingdom; but afterwards altering that will, he named his son Archelaus his successor, giving to Antipas the title only of tetrarch of Galilee and Peræa.

Antipas took a great deal of pains in adorning and fortifying the principal places of his dominions. He married the daughter of Aretas, king of Arabia, whom he divorced about the year of Christ 33, to marry his sister-in-law Herodias, wife to his brother Philip, who was still living. John the Baptist was, by his orders, imprisoned in the castle of Machærus. Josephus attributes this imprisonment to Herod's fear lest John should make use of the authority which he had acquired over the minds of the people to induce them to revolt. But the evangelists, who, from their personal converse with John and his disciples, were better informed than Josephus, assure us that the true reason of imprisoning the Baptist was the aversion which Herod and Herodias had conceived against him for the liberty he had used in censuring their scandalous marriage. The virtue and holiness of John were such that even Herod feared and respected him; but his passion for Herodias would have induced him to kill that prophet, had he not been restrained by his apprehensions of the people, who esteemed John the Baptist as a prophet. (Matt. xiv. 5, 6.) One day, however, while the king was celebrating the festival of his birth with the principal persons of his court, the daughter of Herodias danced before him, and pleased him so well, that he promised with an oath to give her whatever she should ask of him. By her mother's advice she asked the head of John the Baptist; upon which the king commanded John to be beheaded in prison, and the head to be given her.

Aretas, king of Arabia, to revenge the affront which Herod had offered to his daughter, declared war against him, and overcame him in a very obstinate engagement. Herod being afterwards detected as a party in Sejanus's conspiracy, was banished by the Emperor Caligula to Lyons in Gaul, whither Herodias accompanied him. The time of his death is unknown.

ANTIPATER, regent of Macedonia during Alexander's eastern expedition. He gained this distinguished position by his faithful attachment and his prudence. In B.C. 330, he had to subdue the rebellious tribes of Thrace; but even before this insurrection was quelled, another broke out in Peloponnesus, where the Spartan king Agis rose against Macedonia. Having settled the affairs in Thrace as well as he could, Antipater hastened with an army to the south,

and in a battle near Megalopolis, gained a complete victory over the insurgents. He was much molested in his administration of Macedonia by the arrogance and ambition of Olympias, the mother of Alexander. The repeated complaints which both parties sent to Alexander, induced the latter to invite Antipater to Asia, and to appoint Craterus regent in his stead. But before this could be effected, Alexander died at Babylon. In the first division of the empire among the Macedonian generals, it was resolved that Antipater and Craterus should undertake the administration of the European parts of the empire, with the exception of Thrace, which was to be given to Lysimachus. The death of Alexander tempted the Greeks to assert their independence, but the prudence and valour of Antipater crushed all attempts in the Lamian war, and established the Macedonian rule in Greece on a firm footing. At the same time Craterus was engaged in a war against the Ætolians, when news arrived from Asia which induced Antipater to conclude peace with them; for Antigonus reported that Perdiccas was contemplating to make himself sole master of the whole empire. Antipater and Craterus accordingly prepared for war against Perdiccas, and allied themselves with Ptolemy, the governor of Egypt. Antipater crossed over into Asia, B.C. 321; and while still in Syria, he received information that Perdiccas had been murdered by his own soldiers. Antipater now, as administrator of the empire, made several new regulations, and having commissioned Antigonus to continue the war against Eumenes and the other partizans of Perdiccas, returned to Macedonia, where he arrived in B.C. 320. Soon after this he was seized by an illness which terminated his long and active life in B.C. 319. Passing over his son Cassander, he appointed Polysperchon regent, a measure which gave rise to much confusion and ill feeling. (L. S.)

ANTIPATER, an Idumean of illustrious birth, and possessed of great riches and abilities, taking advantage of the confusion into which the two brothers Hyrcanus and Aristobulus plunged Judæa by their contest for the office of high priest, took such measures as to gain for Hyrcanus that office, and under his government to obtain the absolute direction of all affairs. His great abilities raised him to such importance that he was honoured as much as if he had been formally invested with the royal authority. He was at last poisoned by a Jew named Malichus, B.C. 43. He left, among other children, the famous Herod, king of the Jews.

ANTIPATER, *Cœlius*, a Roman historian, who wrote a rhetorical history of the second Punic war, much valued by Cicero. The emperor Hadrian preferred him to Sallust.

ANTIPATER *of Sidon*, a Stoic philosopher, and likewise a poet, commended by Cicero and Seneca. He flourished about the 170th Olympiad. We have several of his epigrams in the *Greek Anthology*.

ANTIPATHY, in *Physiology*, is formed from the two Greek words, ἀντί, *contrary*, and πάθος, *passion*. Literally taken, the word signifies *incompatibility:* but for the most part the term *antipathy* is not used to signify such incompatibilities as are merely physical; it is reserved to express the aversion which an animated or sensitive being feels at the real or ideal presence of particular objects. In this point of view, which is the light in which we at present consider the term, *antipathy*, in common language, signifies a natural and involuntary aversion which a sensitive being feels for some other object, whatever it be, though the person who feels this abhorrence is entirely ignorant of its cause, and can by no means account for it. Such is, they say, the natural and reciprocal hostility between the toad and the weasel, between sheep and wolves. Such is the invincible aversion of particular persons against cats, mice, spiders, &c., a prepossession which is sometimes so violent as to make them faint at the sight of these animals. To

explore the matter without prejudice, we shall find it necessary to abstract from this disquisition all such antipathies as are not ascertained, as that which is supposed to be felt between the salamander and tortoise, and between the weasel and the toad. We must abstract those which can be extinguished or resumed at pleasure; those fictitious aversions which only certain persons feel or pretend to feel. When we abstract aversions, the causes of which are known and evident, we shall be surprised, after deduction of pretended antipathies, how small, how inconsiderable, is the quantity of those which are conformable to our definition. Will any one pretend to call by the name of *antipathy* those real, innate, and incontestable aversions which prevail between sheep and wolves? Their cause is obvious: the wolf devours the sheep, and subsists upon his victims; and every animal naturally flies with terror from pain or destruction: sheep ought therefore to regard wolves with horror, which, for their nutrition, tear and mangle the unresisting prey. From principles similar to this arises that aversion which numbers of people feel against serpents, against small animals, such as reptiles in general, and the greater number of insects. During the credulous and susceptible period of infancy, pains have been taken to impress on our minds the frightful idea that they are venomous; that their bite is mortal; that their sting is dangerous, productive of tormenting inflammations or tumours, and sometimes fatal: they have been represented to us as ugly and sordid; as being for that reason pernicious to those who touch them; as poisoning those who have the misfortune to swallow them. Is it then wonderful (if our false impressions as to this subject have been corrected neither by future reflections nor experiments) that we should entertain during our whole lives an aversion for these objects, even when we have forgot the admonitions, the conversations, and examples, which have taught us to believe and apprehend them as noxious beings? To explain these facts, is it necessary to fly to the exploded subterfuge of occult qualities inherent in bodies, to latent relations productive of antipathies, of which no person could ever form an idea?

To what then are those *antipathies* of which we have heard so much reducible? Either to legendary tales, or to aversions against objects which we believe dangerous, or to a childish terror of imaginary perils, or to a disrelish of which the cause is disguised, or to an infirmity of the stomach,—in a word, to a real or pretended dislike to things which are either invested or supposed to be invested with qualities hurtful to us. Too much care cannot be taken in preventing or regulating the *antipathies* of children; in familiarizing them with objects of every kind; in discovering to them, without emotion, such as are dangerous; and in teaching them the means of defence and security, or the methods of escaping their noxious influence.

ANTIPATHY, in *Ethics*, hatred, aversion, repugnancy. *Hatred* is entertained against persons, *aversion* and *antipathy* indiscriminately against persons or things, and *repugnancy* against actions alone.

ANTIPHILUS *of Egypt*, an eminent painter of antiquity, distinguished for the airy elegance of his style. He was the contemporary of Apelles, whose life he greatly endangered by falsely accusing him of treason before Ptolemy,—but his vile design being brought to light, Apelles was acquitted, and Antiphilus in turn was loaded with chains, and condemned to perpetual slavery.—(Plin. xxxv.; Lucian, *De Calumn.*, lix.)

ANTIPHLOGISTIC (from ἀντί and φλόγωσις, *inflammation*), is a term applied in medicine to the treatment of inflammation by the abstraction of blood, either local or general, the use of purgatives, nauseants, diaphoretics, refrigerants, &c., according to the exigencies of the case.

ANTIPHON, the most ancient of the ten Athenian orators contained in the Alexandrine canon. He was born in B.C. 480 at Rhamnus. During the Peloponnesian war he several times was entrusted with the command of detachments of the Athenian forces, and took an active part in the political affairs of Athens. He had a hand in the overthrow of the democracy, and the establishment of the oligarchy of the Four Hundred in B.C. 411; but as the new government was soon after changed, Antiphon was accused of high treason, and put to death. He must be regarded as the founder of political oratory at Athens, for he was the first that reduced the art of the orator to certain rules and principles. He wrote speeches for others, but never addressed the people himself except at his own trial. Seventeen orations have been preserved under his name, but two or three of them may be spurious. They are printed in the various collections of the Greek orators. From this Antiphon the orator we must distinguish two others; one a philosopher, mentioned by Xenophon (*Memor.* i. 6), who is said to have written about dreams, and the other, a tragic poet, who lived at the court of the elder Dionysius. (L. S.)

ANTIPHONARY, ANTIPHONARIUM, a service-book, which contained all the invitatories, responsories, collects, and whatever else was sung or said in the choir, except the lessons. This is otherwise called *responsorium*, from the responses contained therein. The author of the Roman *antiphonary* was Pope Gregory the Great. We also read of nocturnal and diurnal *antiphonaries*, for the use of the daily and nightly offices; summer and winter *antiphonaries;* also *antiphonaries* for country churches, &c. By the provincial constitutions of Archbishop Winchelsea, made at Merton A.D. 1305, it is required that one of these should be found in every church within the province of Canterbury. The use of these and many other popish books was forbidden by the 3d and 4th of Edward VI., c. 10.

ANTIPHONY, the answer made by one choir to another, when the psalm or answer is sung between two.

ANTIPHONY sometimes denotes a species of psalmody, wherein the congregation, being divided into two parts, repeat the psalms verse for verse alternately. In this sense antiphony stands contradistinguished from symphony, where the whole congregation sing together.

Antiphony differs from responsorium, because in this latter the verse is only spoken by one person, whereas in the former the verses are sung by two choirs alternately. The original of antiphonal singing in the Western churches is referred to the time of St Ambrose, about the year 374. That father is said to have first introduced it into the church of Milan, in imitation of the custom of the Eastern church, where it appears to be of greater antiquity, though as to the time of its institution authors are not agreed. It was probably introduced at Antioch between the years of Christ 347 and 356. Antiphony is also used to denote the words given out at the beginning of the psalm, to which both the choirs are to accommodate their singing. In a more modern sense it denotes a kind of composition made of several verses extracted out of different psalms, adapted to express the mystery solemnised on the occasion.

ANTIPODES, in *Geography*, a name given to those inhabitants of the globe that live diametrically opposite to each other. The word is Greek, and compounded of ἀντί, *opposite*, and πούς, *a foot*, because their feet are opposite to each other. Plato is regarded as the first who thought it possible that antipodes existed, and is looked upon as the inventor of the word. As this philosopher apprehended the earth to be spherical, he had only one step to make to conclude the existence of the antipodes. The ancients in general treated this opinion with the highest contempt, never being able to conceive how men and trees could subsist suspended in the air with their feet upwards, for so they apprehended they must be in the other hemisphere. They never reflected that these terms *upwards* and *downwards* are merely relative, and signify only nearer to, or farther from, the centre of the earth, the common centre to which all heavy bodies gravitate.

ANTIQUARII, a name given to copiers of old books. After the decline of learning among the Romans, and when many religious houses were erected, learning was chiefly in the hands of the clergy, the greater number of whom were regulars, and lived in monasteries. In these houses were many industrious men, who were continually employed in making new copies of old books, either for the use of the monastery or for their own emolument. These writing monks were distinguished by the name of *Antiquarii.*

ANTIQUARY, a person who studies and searches after monuments and remains of antiquity, as old medals, books, statues, sculptures, and inscriptions, and, in general, all curious pieces that may afford any insight into antiquity. In the chief cities of Greece and Italy there were persons of distinction called *antiquaries*, whose business it was to show strangers the antiquities of the place, to explain the ancient inscriptions, and to give them all the assistance they could in this kind of learning. Pausanias calls these antiquaries Ἐξηγηταί. The Sicilians called them *mystagogi.*

ANTIQUARY is also used by ancient writers for the keeper of the antiquarium or cabinet of antiquities. The officer is otherwise called *archæota*, or antiquary of a king, a prince, a state, or the like. Henry VIII. gave John Leland the title of his *antiquary.*

ANTIQUE, in a general sense, something that is ancient: but the term is chiefly used by sculptors, painters, and architects, to denote such pieces of their different arts as were made by the ancient Greeks and Romans. Thus we say, an antique bust, an antique statue, &c.

ANTIQUITIES. See ARCHÆOLOGY.

ANTIRRHINUM, snap-dragon, a genus of plants of the natural order of Scrofularinæ. The best known are the *A. majus*, and *A. orontium.*

ANTISABBATARIANS, a modern religious sect, who oppose the observance of the Christian sabbath. The great principle of the Antisabbatarians is, that the Jewish sabbath was only of ceremonial, not moral obligation, and consequently is abolished by the coming of Christ.

ANTISCII (ἀντί and σκία), those living on different sides of the equator, whose shadows at noon are projected opposite ways. Thus the people of the north are Antiscii to those of the south; the one projecting their shadows at noon towards the north pole, and the other towards the south.

ANTISEPTICS, from ἀντί, and σηπτός, *putrid*, of σήπω, *I putrefy*, an appellation given to such substances as resist putrefaction. We have some curious experiments in relation to antiseptic substances by Dr Pringle, who has ascertained their several virtues. Thus, in order to settle the antiseptic virtue of salts, he compared it with that of common sea-salt, which, being one of the weakest, he supposes equal to unity, and expresses the proportional strength of the rest by the higher numbers, as in the following table:—

Salts, their antiseptic virtue.

Sea salt	1	Saline mixture	3
Sal gemma	1 +	Nitre	4 +
Tartar vitriolated	2	Salt of hartshorn	4 +
Spiritus Mindereri	2	Salt of wormwood	4 +
Tartarus solubilis	2	Borax	12 +
Sal diureticus	2 +	Salt of amber	20 +
Crude sal ammoniac	3	Alum	30 +

In this table the proportions are marked in integral num-

bers; only to some there is added the sign +, to show that those salts are possessed of a stronger antiseptic virtue than the number in the table expresses, by some fractions; unless in the three last, where the same sign imports that the salt may be stronger by some units. To these add kreasote, alcohol, and various metallic salts.

ANTISPASMODICS are medicines proper for the cure of spasms and convulsions. Opium, ammonia, musk, and the essential oils of many vegetables, are the principal in this class of medicines.

ANTISTASIS, in *Oratory*, a defence of an action from the consideration that, had it been omitted, worse would have ensued. This is called by Latin writers *comparativum argumentum;* such, *e. g.*, would be the general's defence who had made an inglorious capitulation, that, without it, the whole army must have perished.

ANTISTHENES, a Greek philosopher, and founder of the sect of the Cynics, who flourished about 380 B.C. He was born at Athens, and passed the early part of his life as a soldier. He was first a pupil of the sophist Gorgias, but afterwards became a zealous disciple and friend of Socrates, whom he faithfully attended till his death. The exhortations of his master to temperance and simplicity of life were carried by him into practice with a strictness bordering on fanaticism. Permitting his beard to grow, he went about the streets in a thread-bare coat, scarcely to be distinguished from a common beggar; an affectation of severity that called forth the satirical remark of Socrates, "that the pride of Antisthenes peeped out through the holes of his cloak." He prided himself upon the most rigid virtue, and thought it his duty to attack the vicious wherever he found them. This gave him some reputation in the city; but it may be supposed that, in the luxurious city of Athens, he had more enemies than disciples. His philosophy was exclusively practical; despising speculative science, he held the nature of things to be undefinable, and all opinions to be identical. Virtue, which he held to be the supreme good, consisted, with him, in temperance, and freedom from the dominion of the passions, by means of which the wise man becomes independent of all external circumstances, and possesses in himself all the sources of felicity and perfection. Virtue is the only beauty; vice the only deformity; all things else are indifferent (ἀδιάφορα) and unworthy of pursuit. Regarding the Deity, as Cicero (*De Nat. Deor.* i. 13) informs us, he held "that the gods of the people were many, but that the true God was One." Notwithstanding the repulsive austerity of his manners, the elevated ethical teaching of Antisthenes drew around him a numerous body of disciples (see CYNICS), of whom the most celebrated was Diogenes of Sinope; and by his twofold influence, positive and negative, he may be regarded as the parent of Stoicism on the one hand, and of Pyrrhonism on the other.

The works of Antisthenes formed, according to Diogenes Laërtius, ten books; of these there are now extant only two discourses entitled *Ajax* and *Ulysses;* and some letters. The collected fragments were published by Winckelmann. Turici, 1842.

ANTISTROPHE, among *Lyric Poets*, that part of a song and dance, in use among the ancients, which was performed before the altar, in returning from west to east: in opposition to strophe.

ANTITACTÆ, in *Ecclesiastical History*, a sect of Gnostics, who held that not God but a creature had created evil; and consequently that it is our duty to oppose ourselves to (ἀντιτάσσεσθαι) this enemy of God.

ANTITHESIS, in *Rhetoric*, a contrast or opposition of words or sentiments. Such is that of Cicero, in the second Catilinarian: "On one side stands modesty, on the other impudence; on one fidelity, on the other deceit; here piety, there sacrilege; here continency, there lust." A judicious use of this figure imparts much force and spirit to style; but its ostentatious recurrence becomes tedious. The poetry of Pope may be cited as an example.

ANTITRINITARIANS, those who deny the Trinity, and teach that there are not three persons in the Godhead. Thus the Samosatenians, who do not believe the distinction of persons in God; the Arians, who deny the divinity of the Word; and the Macedonians, who deny that of the Holy Spirit, are all properly Antitrinitarians. Among the moderns, the term is particularly applied to Socinians, called also Unitarians.

The *Bibliotheca Antitrinitariorum* is a posthumous work of Christopher Sandius, an eminent Antitrinitarian, in which he gives a chronological list of all the Socinian or modern Antitrinitarian authors, with a brief account of their lives, and a catalogue of their works.

ANTITYPE, a Greek word, properly signifying a type or figure corresponding to some other type. The word occurs twice in the New Testament, viz., in the Epistle to the Hebrews, ix. 24, and in St Peter's 1st Ep. iii. 21, where its genuine import has been much controverted. The former says that "Christ is not entered into the holy places made with hands, which are, ἀντίτυπα, the figures or antitypes of the true—now to appear in the presence of God for us." Now τύπος signifies the pattern by which another thing is made; and as Moses was obliged to make the tabernacle, and all things in it, according to the pattern shown him in the mount, the tabernacle so formed was the antitype of what was shown to Moses: anything, therefore, formed according to a model or pattern is an antitype.

ANTITYPE, among the *Ancient Greek Fathers*, and in the Greek liturgy, is also applied to the symbols of bread and wine in the sacrament. Hence it has been argued by many Protestants, that the Greeks do not really believe the doctrine of transubstantiation, because they call the bread and wine *antitypes*, ἀντίτυπα, q. d., *figures*, *similitudes*, and this even after the consecration.

ANTIUM, a celebrated city of the Volsci, on the coast of Latium, now *Porto d'Anzo.* It was the refuge of Coriolanus, and afterwards became a Roman colony. In the time of Cicero it was a favourite retreat of the wealthy citizens. The extent of the ruins shows its importance in ancient times. It is thirty-two miles south-east of Rome.

ANTIVARI, or BAR, a strongly-fortified frontier town and harbour in the Gulf of Venice, in the Turkish pachalic of Iscander or Scutari. It is the seat of a Catholic bishop, and contains 6000 inhabitants, many of whom own vessels, which are hired for the coasting trade of the Adriatic. Lat. 42. 2. N. Long. 19. 10. E.

ANTLIA, an ancient machine, supposed to be the same with our pump. Hence the phrase *in antliam condemnari*, according to the critics, denotes a kind of punishment whereby criminals were condemned to drain ponds, ditches, or the like. But prior to the invention of the pump this word was applied indifferently to any implement for drawing water; and even so late as the time of St John ἄντλημα is used to signify merely *a bucket with a rope.* John. iv. 11.

ANTLIA, in *Entomology*, the oral instrument of lepidopterous insects, used for suction.

ANTŒCI (ἀντί and οἰκέω), those who live under the same meridian, and at the same distance from the equator; the one toward the north, and the other toward the south. Hence they have the same longitude; and their latitude is also the same, but of a different denomination: they are in the same semicircle of the meridian, but in opposite parallels: they have precisely the same hours of the day and night, but opposite seasons; and the night of the one is always equal to the day of the other.

ANTOINE, St, a town of France, in the department of Isere, with a celebrated abbey. It is seated among the mountains, eight miles W.N.W. of St Marcellin. Pop. 2007.

ANTONELLO *Da Messina*, the first Italian painter who used *oil colours*. Having seen, in the palace of Alfonso I. of Naples, a picture of Jan Van Eyck in this style, he set out for Flanders, and obtained the secret from the painter of Bruges, with whom he remained until the death of Van Eyck in 1445. After that he returned to Messina for a time; but in 1450 set out for Venice, where he communicated the important Flemish secret to Domenico Veneziano. He then paid a long visit to Milan; but finally returned to Venice, where he died in 1493. He seems to have freely communicated the modes of painting in oil, especially in this latter period of his life, and had a salary from the state. He had a high reputation, and was the most illustrious artist in the first epoch of the Neapolitan school.—See *Ridolfi Vite de Pittori*, *Zanetti Pint. Venez.*, and *Lanzi Storia Pittorica*, tom. ii. (T. S. T.)

ANTONIA, a fortress in Jerusalem, on the north side of the area of the temple, originally built by the Maccabees, under the name of Baris, and afterwards rebuilt with great strength and splendour by the first Herod. Josephus states that the fortress stood upon a rock or hill fifty cubits high, at the north-west corner of the temple area, above which its walls rose to the height of forty cubits. Within, it had the extent and appearance of a palace, being divided into apartments of every kind, with galleries and baths, and broad halls or barracks for soldiers; so that, having everything necessary within itself, it seemed a city, while in magnificence it resembled a palace. The fortress communicated with the northern and western porticoes of the temple area, and had flights of stairs descending into both, by which the garrison could at any time enter the courts of the temple, and prevent tumults. This is the "castle" into which Paul was carried from the temple by the soldiers: and from the stairs of which he addressed the people collected in the adjacent court (Acts xxi. 31–40).

ANTONIAN Waters, medicinal waters of Germany, very pleasant to the taste, and esteemed in many chronic and hypochondriac cases.

ANTONIANO, Silvio, a man of great learning, who raised himself from a low condition by his merit, was born at Rome in the year 1540. At the age of ten he could make verses impromptu on any subject proposed. The duke of Ferrara, coming to Rome to congratulate Marcellus II. on his elevation to the pontificate, was so charmed with the genius of Antoniano, that he carried him to Ferrara, where he made him professor of literature at the age of sixteen. From thence he was sent for by Pius IV., who made him professor of the belles lettres in the college of Wisdom at Rome. Antoniano filled this place with so much reputation, that, on the day when he began to explain the oration of Cicero *pro Marcello*, he had among his numerous auditors no less than twenty-five cardinals. He was afterwards chosen rector of the college; and after the death of Pius IV., being seized with a spirit of devotion, he joined himself to Filippo Neri, and accepted the office of secretary to the sacred college, offered him by Pius V., which he held for twenty-five years. He refused three bishoprics which Gregory XIV. would have given him; but he accepted the office of secretary to the Briefs, offered him by Clement VIII., who made him his chamberlain, and afterwards a cardinal. His excessive application to study brought on a sickness, of which he died in the sixty-third year of his age. A work of his on education was published at Verona in 1584, 4to; and some *Orations* appeared after his death in 1610, 4to, Rome. He wrote, besides, numerous discourses and poems, both in Latin and Italian.

ANTONIDES, Hans, surnamed Vander Goes, an eminent Dutch poet, was born at Goes in Zealand on the 3d of April 1647. His parents were Anabaptists, people of good character, but in poor circumstances. They went to live at Amsterdam when Antonides was about four years old; and in the ninth year of his age he began his studies, under the direction of Hadrian Junius and James Cocceius. The study of the Latin poets first awakened his poetic spirit. His earliest attempts were translations from Horace and Ovid; and, having formed his taste on these excellent models, he at length ventured to write a tragedy, entitled, *Trazet, or the Invasion of China;* which, however, his modesty prevented him from publishing.

His parents designed him for an apothecary; but his remarkable genius for poetry soon gained him the esteem and friendship of several persons of distinction, and particularly of Buisero, one of the lords of the admiralty at Amsterdam, who sent him at his expense to pursue his studies at Leyden. There he took his degree of doctor of physic, after which his patron gave him a place in the admiralty. He died on the 18th September 1684, at the early age of 37. A complete edition of his works, with a life of the poet, was printed at Amsterdam, 4to, 1714. The most esteemed of his poems, which are characterised by warmth and vigour, is his epic on the river Y, entitled *Y-stroom.*

ANTONIN, St, a town of France, department of Tarn and Garonne, in a valley at the confluence of the rivers Aveyron and Bonnette, 22 miles north-east of Montauban. It is the capital of a canton, and has 2691 inhabitants. The manufactures are linen, leather, woollens, &c.

ANTONINI Itinerarium. See Itinerary.

ANTONINUS Liberalis, a Greek grammarian, who probably lived about A.D. 147. His work on metamorphoses is chiefly valuable for the study of Greek mythology. One of the best editions is that of Koch, Leipz. 1832, 8vo.

Antoninus, *Marcus Aurelius*, surnamed the *Philosopher*, a very eminent Roman emperor, born at Rome on the 20th of April, A.D. 121. He was called by several names till he was admitted into the Aurelian family, when he took that of Marcus Aurelius Antoninus. Hadrian, upon the death of Ceionius Commodus, turned his eyes upon Marcus Aurelius; but, as he was not then 18 years of age, and consequently too young for so important a station, he fixed upon Antoninus Pius, whom he adopted, upon condition that he should likewise adopt Marcus Aurelius. The year after this adoption, Hadrian appointed him questor, though he had not yet attained the age prescribed by law. After the death of Hadrian, Aurelius married Faustina, the daughter of Antoninus Pius, by whom he had several children. In the year 139 he was invested with new honours by the Emperor Pius, which he bore in such a manner as endeared him to that prince and the whole people.

On the death of Pius, in the year 161, he was invested by the senate with the imperial power, taking as his colleague L. Ceionius Commodus, thenceforward called L. Aurelius Verus. Dion Cassius says that he was induced to this by his ill health, and the desire of leisure to pursue his studies; Lucius being of a strong, vigorous constitution, and consequently more fit for the fatigues of war. The same day he assumed the name of Antoninus, which he bestowed likewise on his colleague Verus, to whom, at the same time, he betrothed his daughter Lucilla.

The happiness which the empire began to enjoy under the two emperors was soon interrupted. In the year 162, a dreadful inundation of the Tiber destroyed a vast number of cattle, and occasioned a famine at Rome. This calamity was followed by the Parthian war; and at the same time the Catti ravaged Germany and Rhætia. Lucius Verus went in person to oppose the Parthians; and Antoninus remained

at Rome, where his presence was necessary. Less through the ability of Verus than the conduct of his lieutenant, the war with the Parthians was successfully terminated. The two emperors shared the honours of a magnificent triumph at Rome in the year 166, and were honoured with the title of *Fathers of their country*. In this year the city was ravaged by famine and by a terrible pestilence which spread itself over the whole world. It was likewise in this year that the Marcomanni, and many other people of Germany, took up arms against the Romans; but the two emperors, having marched in person against them, obliged them to sue for peace. The war, however, was renewed the year following, and the two emperors again opened the campaign in person. Lucius Verus was seized with an apoplectic fit, and died at Altinum. The whole conduct of the war now devolved on his successor, who found his resources so straitened, that to save the people from new taxes, he parted with the plate and furniture of his palace, and even with the empress's jewels, in order to meet the demands of the war. His self-denying and vigorous exertions were crowned with the greatest success.

During this war, in 174, a very extraordinary event is said to have happened, which, according to Dion Cassius, was as follows: Antoninus's army being blocked up by the Quadi in a very disadvantageous place, where there was no possibility of procuring water, and being worn out with fatigue and wounds, oppressed with heat and thirst, and incapable of retiring or engaging the enemy, in an instant the sky was covered with clouds, and there fell a vast quantity of rain. The Roman army were about to quench their thirst when the enemy came upon them with such fury, that they must certainly have been defeated, had it not been for a shower of hail, accompanied with a storm of thunder and lightning, which fell upon the enemy without the least annoyance to the Romans, who by this means gained the victory.[1] In 175 Antoninus made a treaty with several nations of Germany. Soon after, Avidius Cassius, governor of Syria, urged on by Faustina, revolted from the emperor. This insurrection, however, soon ended in the murder of Cassius by his own partisans. Antoninus behaved with great lenity towards those who had been engaged in Cassius's party: he would not put to death, nor imprison, nor even sit in judgment himself upon any of the senators engaged in this revolt; but he referred them to the senate, fixing a day for their appearance, as if it had been only a civil affair. He wrote also to the senate, desiring them to act with indulgence rather than severity; nor to shed the blood of any senator or person of quality, or of any other person whatever; but to allow this honour to his reign, that, even under the misfortune of a rebellion, none had lost their lives except in the first heat of the tumult. In 176 Antoninus visited Syria and Egypt. The kings of those countries, and ambassadors also from Parthia, came to visit him. He staid several days at Smyrna; and, after settling the affairs of the East, went to Athens; on which city he conferred several honours, and appointed public professors there. From thence he returned to Rome with his son Commodus, whom he chose consul for the year following, though he was then but 16 years of age, having obtained a dispensation for that purpose. On the 27th of September in the same year he gave him the title of *Imperator;* and on the 23d of December he entered Rome in triumph with Commodus, on account of the victories gained over the Germans. Dion Cassius tells us that he remitted all the debts which were due to himself and the public treasury during 46 years, and burnt the writings relating to these debts. In the year 177 he left Rome with his son Commodus, to march against the Marcomanni and other barbarous nations. In the following year he gained a considerable victory over them, and would in all probability have entirely subdued them, had he not been seized with an illness, which carried him off on the 17th of March 180, in the 59th year of his age, and 20th of his reign. The character of this prince affords the highest instance of what the Stoical philosophy could do in moulding a disposition naturally tranquil and benevolent. Alike in his public and private life, Antoninus moved like a superior being among the rest of mankind. Master of himself, and ever influenced by the highest motives which heathen morality could suggest, he was deeply and universally beloved; and a people who believed in the divine descent of Romulus and his bodily return to heaven, might well celebrate with more than empty ceremony the apotheosis of Antoninus, and reverently set up his statue in their houses. But his persecution of the Christians, to which, doubtless, he was instigated by evil counsellors, is an indelible stain on a character otherwise so estimable. The martyrdom of Justin at Rome, of the venerable Polycarp, with many others at Smyrna, took place about the 7th year of his reign; and that he sanctioned the horrible atrocities perpetrated at Vienna and Lyons ten years later, is confirmed by the answer returned to the Roman governor, who applied for instructions, that all who professed Christianity should be put to death. The only work of his that remains, besides some letters in the remains of Fronto, discovered by Mai at Rome, is his book of Meditations, originally written in Greek (τῶν ἐις ἑαυτὸν βιβλία δώδεκα). It consists of miscellaneous reflections on moral and religious subjects, expressive of the thoughts and feelings of the writer, in the midst of the daily business of life, the manifold cares and routine of a court, or the distracting tumult of the camp. Together with the writings of Epictetus, these form the most valuable remains of the Stoical school, and faithfully describe the mode of self-discipline by which its higher representatives formed their minds in the habit of virtue. The best edition is that of Gataker, Cantab. 1652, reprinted, London, 1697, with Dacier's notes and life of Antoninus, translated into Latin by Stanhope. It has been frequently translated. The best English version is that by Drs Moor and Hutcheson, 2 vols. 12mo, 1749.

Eusebius, *E. H.* iv. 16.

Antoninus, *Titus Aurelius Fulvus Boionius Arrius*, surnamed *Pius*, emperor of Rome, was born A.D. 86, at Lanuvium in Italy. The family of his father, from whom he inherited great wealth, was originally from Nismes in Gaul. Both his father and grandfather had held the office of consul. Arrius Antoninus, his maternal grandfather, by his amiable disposition and love of literature, had acquired an eminent character, and was very intimate with Pliny the younger. Under him the young Titus, after his father's death, completed his education. His character, on arriving at the age of maturity, manifested itself in the most promising manner. To an outward mien at once mild and dignified, he joined a cultivated understanding, a virtuous heart, and a manly eloquence. Simple in his tastes, and

[1] The Pagans, as well as Christians, according to M. Tillemont (art. xvi. p. 621), have acknowledged the truth of this prodigy, but have greatly differed as to the cause of such a miraculous event, the former ascribing it, some to one magician and some to another. In Antoninus's pillar the glory is ascribed to Jupiter, the god of rain and thunder. But the Christians affirmed that God granted this favour at the prayer of the Christian soldiers in the Roman army, who are said to have composed the twelfth or Melitene legion; in consequence of which they received the title of the *Thundering Legion.* (Euseb. *Eccles. Hist.* lib. v. cap. 5.) Mr Moyle, in the letters published in the second volume of his works, has endeavoured to explode this story of the Thundering Legion, to which Mr Whiston published an answer in 1726. More recently the subject has been extensively argued on both sides, with an ingenuity scarcely demanded by its importance.

Antoninus. guided by temperance in all his sentiments and actions, he was entirely free from the usual vices of imperial rank.

In the year 120, among the many public honours which his birth and connections gave him a claim to, he was elevated to the high post of consul, and was afterwards appointed by Hadrian to be one of the four consulars among whom the supreme power of Italy was divided. Becoming in his turn proconsul of Asia, he acquitted himself with such reputation that he even excelled his grandfather Arrius, who had formerly enjoyed that high trust. Returning from Asia, he was received into the favour and confidence of Hadrian. He married Annia Faustina, the daughter of Annius Verus, whose character was far from being irreproachable; but his lenient disposition induced him to avoid public scandal, and he behaved towards his aged father-in-law with the most becoming respect. Two sons and two daughters were the fruits of this marriage. The sons died young, and the eldest daughter, who was married to Lamia Syllanus, died, when Titus proceeded towards his Asiatic government. Faustina, the youngest, married Marcus Aurelius, who was afterwards emperor.

After the death of Verus, Hadrian adopted Antoninus as his successor in the Roman empire, with the title of Cæsar, A.D. 138; and at the same time created him his colleague in the proconsular and tribunitian offices. Extending his plans of adoption still farther, he caused Antoninus to adopt the son of Verus, then seven years of age, and Marcus Annius, afterwards named Aurelius, then seventeen years of age, a relation of Hadrian's, and nephew to his own wife. The dutiful and merited attention which Antoninus bestowed on Hadrian during the last months of his illness, justifies, in conjunction with his general character, the epithet afterwards bestowed upon him. On July 10, A.D. 138, he succeeded to the empire amidst the universal acclamations of the senate and people, who anticipated in his well-tried virtues that happiness which a good and wise sovereign is able to bestow upon his subjects.

The Roman world enjoyed such tranquillity under his reign that it affords few materials for history; yet it is to be regretted that Capitolinus is the only historian from whom any direct information can be received concerning this peaceful period, and he is none of the most perspicuous. It however appears that the usual honours and titles, together with the addition of the surname of Pius, which the general tenor of his life and his zeal in defending and honouring the memory of his predecessor united to suggest, were willingly conferred upon him by the senate. In the beginning of his reign there were several conspiracies formed against him; but these only afforded him opportunities of signalizing his singular clemency. Though unable to prevent the course of justice against the ringleaders, he prohibited the prosecution of their accomplices, and took the son of Attilius, one of the principal conspirators, under his protection. Various commotions were raised in several parts of the empire; but by the vigilance of his lieutenants these were easily quelled. The incursions of the Brigantes in Britain were restrained, and a new wall which was built to the north of that of Hadrian, extending from the Forth to the Clyde, and which was called the *Wall of Antoninus*, was fixed as the boundary of the Roman province in Britain. The reign of Antoninus, upon the whole, was singularly peaceful, and realised a saying of Scipio, that "he preferred saving the life of one citizen, to destroying a thousand enemies."

Jurisprudence was to this emperor, as it was to his predecessor, an interesting subject for improvement; and several decrees which he issued display his commendable spirit of equity. The natural consequence of this equity was, that Antoninus acquired a reputation and fame which no military achievements could have conferred; and his friendship was courted by the neighbouring princes.

There is scarcely a blot to be found to tarnish his character; and frugality, modesty, and harmless amusement continued to employ his private hours. In the management of his complicated business he was exact to such a degree, that it was even ridiculed by some; but he found the daily advantage of this accuracy. The growing virtue of Marcus Aurelius soon drew his attention after he ascended the throne, and having given him his daughter in marriage, he declared him Cæsar. Nor was he mistaken in his choice; for Aurelius acted with the utmost fidelity and affection amid all the honours that he continued to confer upon him. But his prosperous reign was drawing to a close: in the 75th year of his life he was seized with a fever at his favourite country-seat of Lorium. Assured of his approaching death, he convened the principal officers of the state, confirmed his election of Aurelius, and gave him the imperial ensigns. A delirium ensued, in an interval of which the tribune of the night-watch having came, as was customary, to receive the pass-word, the dying emperor uttered the stoical watchword *Æquanimitas*, and calmly resigned his breath in the 23d year of his reign. His ashes were consigned to the tomb of Hadrian, and divine honours paid to his memory. He was universally regretted, and succeeding emperors for more than a century bore his name as a title of honour. The senate and his successor erected a sculptured pillar to his memory, which still exists as one of the chief ornaments of the city of Rome.

Antoninus's Wall. ANTONINUS'S WALL, the name of the third rampart or defence that had been built or repaired by the Romans against the incursions of the North Britons. It is called by the people in the neighbourhood *Graham's Dike*, from the opinion that one Graham, or Grimus, first made a breach in it after the retreat of the Romans out of Britain. The first barrier erected by the Romans was the chain of forts made by Agricola from the firth of Forth to that of Clyde, in the year 81, to protect his conquest from the inroads of the Caledonians. The second was the vallum or dike thrown up by Hadrian in the year 121. It terminated on the western side of the kingdom at *Axelodunum* or *Brugh*, on the Solway sands, and at *Pons Ælii* or *Newcastle* on the eastern. The rampart of Hadrian was situated much farther south than Agricola's chain; the country to the north having been either recovered, according to some authors, by the native Britons after the departure of Agricola, or, according to others, voluntarily slighted by Hadrian. However, this work of Hadrian's did not long continue to be the extreme boundary of the Roman territories to the north in Britain; for Antoninus Pius, the adopted son and immediate successor of Hadrian, having, by his lieutenant Lollius Urbicus, recovered the country once conquered by Agricola, commanded another rampart to be erected between the firths of Forth and Clyde, in the track where Agricola had formerly built his chain of forts. The great number of inscriptions which have been found in or near the ruins of this wall or rampart, to the honour of Antoninus Pius, leave us no room to doubt its having been built by his direction and command. If the fragment of a Roman pillar with an inscription, now in the college library of Edinburgh, belonged to this work, as is generally supposed, it fixes the date of its execution in the third consulship of Antoninus, which was A.D. 140, only twenty years after that of Hadrian, of which this seems to have been an imitation. This wall or rampart, as some imagine, reached from Carriden on the firth of Forth to Old Kirkpatrick on the Clyde; or, as others think, from Kinniel on the east to Dunglass on the west. These different suppositions hardly make a mile of difference in the length of this work, which, from several actual mensurations, appears to have been 37 English or 40 Roman miles. Capitolinus, in his life of Antoninus Pius, directly affirms that

the wall which that emperor built in Britain was of turf. This in the main is unquestionably true, though it is evident (from the vestiges of it still remaining, which not very many years ago were dug up and examined for near a mile together) that the foundation was of stone. Mr Camden also tells us that the principal rampart was faced with square stone, to prevent the earth from falling into the ditch. The chief parts of this work were as follows: 1. A broad and deep ditch, whose dimensions cannot now be discovered with certainty and exactness, though Mr Pont says it was 12 feet wide. 2. The principal wall or rampart was about 12 feet thick at the foundation, but its original height cannot now be determined. This wall was situated on the south brink of the ditch. 3. A military way on the south side of the principal wall, well paved, and raised a little above the level of the ground. This work, as well as that of Hadrian, was defended by garrisons placed in forts and stations along the line of it. The number of these forts or stations, whose vestiges were visible in Mr Pont's time, was 18, situated at about the distance of two miles from each other. In the intervals between the forts there were turrets or watch-towers; but the number of these, and their distance from each other, cannot now be discovered.

It is not a little surprising, that though it is now more than 1700 years since this work was finished, and more than 1400 since it was neglected, we can yet discover, from authentic monuments which are still remaining, by what particular bodies of Roman troops almost every part of it was executed. This discovery is made from inscriptions upon stones, which were originally built into the face of the wall, and have been found in or near its ruins. From these inscriptions it appears in general, that this great work was executed by the second legion, the vexillations of the sixth legion and of the twentieth legion, and one cohort of auxiliaries. Some of these inscriptions have suffered greatly by the injuries of time and other accidents; so that we cannot discover from them with absolute certainty how many paces of this work were executed by each of these bodies of troops. The sum of the certain and probable information contained in these inscriptions, as it is collected by Mr Horsley, stands thus:

	Paces.
The second legion built	11,603
The vexillation of the twentieth legion	7,411
The vexillation of the sixth legion	7,801
All certain	26,815
The vexillation of the twentieth legion, the monument certain, and the number probable	3,411
The same vexillation on a plain monument, no number visible, supposed	3,500
The sixth legion, a monument, but no number, supposed	3,000
Cohors prima Cugernorum	3,000
Total	39,726

or 39 Roman miles 726 paces, nearly the length of the wall. It would be both useful and agreeable to know how long these troops were employed in the execution of this great work. But of this we have no information. Neither do we know what particular bodies of troops were in garrison in the several forts and stations along the line of this wall, because these garrisons were withdrawn before the *Notitia Imperii* was written.—See *Gordon's Itinerarium Septentrionale, and Maitland's History of Scotland.*

Though we cannot discover exactly how many years this wall of the Emperor Antoninus continued to be the boundary of the Roman territories in Britain, yet we know with certainty that it was not very long. For we are told by an author of undoubted credit (Dion Cassius, lib. lxxii.), that, in the reign of Commodus, A.D. 180, "he had wars with several foreign nations, but none so dangerous as that of Britain; for the people of the island having passed the wall which divided them from the Romans, attacked them, and cut them to pieces."

ANTONIO, Nicholas, knight of the order of St James, and canon of Seville, was born at Seville in 1617, being the son of a gentleman whom King Philip IV. made president of the admiralty established in that city in 1626. After having gone through a course of philosophy and divinity in his own country, he studied law at Salamanca. Upon his return to Seville, he shut himself up in the royal monastery of Benedictines, where he employed himself several years in writing his *Bibliotheca Hispanica,* having the use of the books of Bennet de la Sana, abbot of that monastery, and dean of the faculty of divinity at Salamanca. By this help, and about 30,000 volumes in his own library, joined to continual labour and indefatigable application, he was at last enabled to finish his *Bibliotheca Hispanica,* in four volumes folio, two of which he published at Rome in the year 1672. The work consists of two parts; the one containing the Spanish writers who flourished before the fifteenth century, and the other those since the end of that century. After the publication of these two volumes, he was recalled to Madrid by King Charles II. At his death, which took place in 1684, he left nothing but his vast library; and his two brothers and nephews being unable to publish the remaining volumes of his *Bibliotheca,* sent them to Cardinal d'Aguisine, who paid the expense of the impression, and committed the superintendence of it to M. Martin, his librarian, who added notes in the name of the cardinal. These two volumes were published in 1696. Improved editions of both these works, by F. P. Bayer, were published at Madrid in 4 vols. folio, in 1783–8. A work by Antonio was published for the first time at Valencia in 1742, entitled *Censura de Historias Fabulas, obra postuma,* folio.

ANTONIUS, Marcus, a famous Roman orator. While he filled the office of prætor, Sicily fell to his lot, and he cleared the seas of the pirates which infested that coast. He was made consul with A. Postumius Albinus, in the year B.C. 99, when he opposed the turbulent designs of Sextus Titus, tribune of the people, with great resolution and success. Some time after he was made governor of Cilicia, in quality of proconsul, where he performed so many great exploits that he obtained the honour of a triumph. He was one of the greatest orators ever known at Rome; and it was owing to him, according to the testimony of Cicero, that Rome might boast herself a rival even to Greece itself in the art of eloquence. He never would publish any of his pleadings, that he might not, as he said, be proved to say in one cause what might be contrary to what he should advance in another. He was killed, B.C. 87, during those bloody confusions raised at Rome by Marius and Cinna. His hiding-place being discovered, soldiers were sent to despatch him; but the power of his eloquence so moved them, that none but he who commanded them, and had not heard his discourse, had the cruelty to kill him. His head was exposed before the rostra, a place which he had adorned with his triumphal spoils.

Antonius, *Marcus,* the triumvir, was born about the year B.C. 83. He was grandson to M. Antonius the orator, and the son of that M. Antonius who was surnamed in derision *Creticus,* from the place where he died, after plundering the provinces he was appointed to defend. Antonius being very young when his father died, he was brought up by Cornelius Lentulus, who married his mother Julia, and was afterwards put to death by Cicero as one of Catiline's conspirators; an act afterwards fatally revenged by Antony, whose hatred for Cicero was sharpened by his philippics against himself. After involving his affairs deeply by dissipation and extravagance, in his twenty-fifth year he joined the army in Syria,

where he served with distinction under A. Gabinius; and during the three succeeding years he took part in the campaigns against Aristobulus in Palestine, and in the restoration of Ptolemy Auletes to the throne of Egypt. He served afterwards under Cæsar in Gaul; and when the civil war broke out, he took Cæsar's part, and was made a tribune of the people, in which office he did Cæsar great service. Cæsar, having made himself master of Rome, gave Antony the government of Italy. At the battle of Pharsalia Cæsar confided so much in him, that he gave him the command of the left wing of his army, while he himself led the right. After Cæsar was made dictator he made Antony general of the horse, though he had never been prætor; in which command he exerted his power with the utmost violence. He was made consul when Cæsar enjoyed that honour for the fifth time, the last year of that usurper's life. On Cæsar's death he harangued the populace with great art, and raised their fury against his murderers, flattering himself that he should easily get into the place which Cæsar had filled; but his haughty behaviour lost him all the advantages his affected concern for Cæsar had gained him. His ill-treatment of Octavius, and quarrel with him, produced another civil war, which ended in an accommodation between him, Octavius, and Lepidus, fatal to the peace of Rome. They agreed to share the supreme power among them; and many of the most illustrious Romans were sacrificed by proscription to cement this bloody league, which is known by the name of the *Second Triumvirate*. The year B.C. 42 was remarkable for the decisive victory gained by Antony and Octavius over the republican forces at Philippi, and the death of Brutus and Cassius. But the triumvirs were too ambitious, and hated one another too much, to be long united. Antony went into Asia to raise money for his soldiers, and during his absence Fulvia, his wife, quarrelled with Octavius. When Antony was in Asia, indulging himself in all manner of luxury, the famous Cleopatra inspired him with the most violent passion. Hearing of the quarrel between Fulvia and Octavius, and finding Octavius was become publicly his enemy, Antony entered into a confederacy with Sextus Pompeius, who was still master of Sicily. He then went into Italy to fight against Octavius; but Fulvia, who had been the author and promoter of this war, dying, Octavius and Antony came to an agreement. One of the conditions of this new peace was, that they should together attack Pompey, though the former had lately made an alliance with him. Antony then married Octavia, sister of Octavius, as a pledge of their renewed friendship, but returning soon after to his beloved Cleopatra, he sent back Octavia to her brother. Antony now assumed the state and ceremony of an Eastern prince. His invasion of Parthia had been attended with a severe defeat; but more fortunate in Armenia, he obtained possession of the person of king Artavasdes, and carried him to Alexandria. His arbitrary conduct having at length alienated many of his friends and supporters, Octavius seized the opportunity to accomplish his ruin. They engaged in the memorable sea-fight off Actium, on the 2d Sept. B.C. 31, when the untimely flight of Cleopatra with the greater part of the fleet hastened Antony's defeat. They fled together to Alexandria, where in the following year Antony, betrayed by Cleopatra and assailed by Octavius, put an end to his own life by falling on his sword. See CLEOPATRA.

ANTONOMASIA, from ἀντί and ὄνομα, a figure of rhetoric by which a substitution is used for a proper name. It may be either the employment of a patronymic, a characteristic epithet, or the substitution of another name for that of the individual. Thus Homer uses "Pelides" and "Atrides" for Achilles and Agamemnon; Aristotle is denominated "the Stagyrite;" Pope designates Charles XII. and Alexander the Great "the Swede," and "Macedonia's madman;" Thomson terms Charles "the frantic Alexander of the north."

ANTOSIANDRIANS, a sect of rigid Lutherans, who opposed the doctrine of Osiander relating to justification. These are otherwise denominated *Osiandromastiges*. The Antosiandrians deny that man is made just with that justice wherewith God himself is just; that is, they assert that he is not made essentially, but only imputatively, just; or, that he is not really made just, but only pronounced so.

ANTRIM, a maritime county in the northern extremity of Ireland, in the province of Ulster, situate between 54. 26. and 55. 12. 16. N. Lat. and 5. 47. and 6. 52. W. Long. It comprises, according to the Ordnance survey, an area of 745,177 acres or 1164 square miles, of which 503,288 are arable, 176,335 uncultivated, 10,358 in plantations, 1908 in towns, and, including a portion of Lough Neagh, 53,288 under water. In addition to the above, the county with the town of Carrickfergus contains 16,700 acres, or 26 square miles; of which 12,483 are arable, 4088 uncultivated, and 129 in the town, making the total area of the county 761,877. Antrim presents a considerable line of coast to the northern Ocean, by which it is bounded on the north, and the Irish Channel, which forms its eastern boundary; Carrickfergus Bay, or Belfast Lough, and the River Lagan, divide it from the county of Down. The winding shores of Lough Neagh and Lough Beg, together with the River Bann, form its boundaries on the west until the River Bann touches the liberties of Coleraine, which then complete the western boundary. In superficial extent Antrim is exceeded by eight other counties in Ireland, but the extensive county of Cork alone supports a more numerous population.

In 1584-5, the county was divided by the lord-deputy, Sir John Perrot, into eight baronies; but of late years, by the subdivision of six of the old baronies into upper and lower, it has been divided into fourteen baronies, viz., Antrim, Lower and Upper; Belfast, Lower and Upper; Cary Dunluce, Lower and Upper; Glenarm, Lower and Upper; Kilconway, Massareene, Lower and Upper; Toome, Lower and Upper. There are also smaller divisions, as parishes, granges, manors, and townlands. The number of parishes, and parts of parishes, is 75, all of which are in the diocese of Connor, except the parish of Aghalee, in the barony of Upper Massareene, which is in Dromore diocese. There are seven poor-law unions in the county,—Antrim, Ballycastle, Ballymena, Ballymoney (partly in Londonderry county), Lisburn (partly in Down county), and Larne. There is a revenue police-station at Ballymoney, and 21 coast-guard stations, with 145 officers and men. The headquarters of the constabulary force, which consists of 229 officers and men, are at Ballymena, the county being divided into six districts. Antrim is in the Belfast military district, the headquarters of which, and also of the county militia, are at Belfast. The fishery districts are Ballycastle and Carrickfergus, comprising 121 miles of maritime boundaries, which in 1852 had 764 registered vessels, employing 2468 men and boys. The amount of property valued under the Act 6th and 7th Will. IV. cap. 84 (Griffith's valuation), was L.479,934, and the net annual value of property rated to the poor is L.702,917. The county sends six members to the imperial parliament, two for the shire,—constituency, in 1851, under 13th and 14th Vict., c. 69, 8207; two for Belfast borough,—constituency 2697; and one for each of the boroughs of Carrickfergus and Lisburn, constituencies, 720 and 188.

The assizes, formerly held at Carrickfergus, are now held at Belfast, which has recently been proclaimed the county town. Quarter-sessions are held at Antrim, Ballymena, Ballymoney, Belfast, and Carrickfergus. There are three savings-banks in the county, Belfast, Gracehill, and Lisburn,

Antrim. the deposits in which amounted in 1851 to L.116,424, a sum exceeding that deposited in the savings-bank of any other county in Ireland except Cork. The principal towns are—Belfast, population in 1851, 100,300; Carrickfergus, 8543; Antrim, 2324; Ballymena, 6136; Larne, 3076; and Lisburn, 6569.

The earliest known inhabitants were of Celtic origin, and the names of the townlands or subdivision, supposed to have been made in the thirteenth century, are pure Celtic. In addition to the intrusion of the Danish marauders, who infested all the eastern part of Ireland, Antrim was exposed to the inroads of the northern Scots, who ultimately effected permanent settlements here. The antiquities of the county consist of cairns, mounts, or forts, remains of ecclesiastical and military structures, and round towers. The principal cairns are—one on Colin mountain, near Lisburn; one on Slieve True, near Carrickfergus; and two on Colinward. The cromlechs most worthy of notice are one near Cairngrainey, to the north-east of the old road from Belfast to Templepatrick; the large cromlech at Mount Druid, near Ballintoy; and one at the northern extremity of Ireland, Magee. The mounts, forts, and intrenchments, are very numerous. There are four round towers in the county: one at Antrim 95 feet high (of which part only is standing), in the churchyard of Armoy, about four miles from Ballycastle; one on Ram island in Lough Neagh 43 feet high, a portion of which has evidently fallen; and the fragment of one between Lisburn and Moira, near the old church of Trummery. Of the ecclesiastical establishments enumerated by Archdall, there are some remains of those of Bonamargy, Kells, Glenarm, Glynn, Muckamore, and White Abbey. The noble castle of Carrickfergus, together with some additions, is the only one in perfect preservation. There are, however, remains of other ancient castles, of which the most interesting is the old castle of Dunluce, remarkable for its great extent and romantic situation.

A large proportion of the surface of the county consists of mountains and bogs. The mountains, occupying about one-third of the area of the county, stretch from south to north, terminating on the northern shore in abrupt and almost perpendicular declivities; they attain their greatest elevation near the coast, having a gradual descent inland, so that many of the principal streams have their source near the sea and flow thence into Lough Neagh. The eastern portion of the county is mountainous, nearly destitute of wood and abounding in bogs, which, from their situation appear irreclaimable; this character also, in some measure, applies to the northern portion, and it is computed that about 120,000 acres are incapable of improvement. On the western side of the mountain range, the valleys expand to a considerable width and are of great fertility, especially that of Six-mile-water, stretching towards the town of Antrim and the beautifully undulating surface of the valley of the Lagan. As it approaches the River Bann, the inclination of the mountainous region becomes less rapid, and is occupied by turf bogs susceptible of improvement. In the southern part of the barony of Toome, and along the shores of Lough Neagh, lies the most extensive level tract of well cultivated and fertile land within the county. From Belfast to Carrickfergus, and from thence to Larne between the mountain range and the sea, are tracts of very fertile land. The most remarkable ranges of cliffs are those of perpendicular basaltic columns (see GIANT'S CAUSEWAY), which extend for many miles along the northern shore, and are most strikingly displayed in Fair Head and the Giant's Causeway.

Lough Neagh, the largest lake in the United Kingdom, and, excepting Lake Ladoga, Lake Vener, and the Lake of Geneva, the most extensive in Europe, is principally in the county of Antrim. It is about 20 miles in length, 12 in breadth, and 80 miles in circumference, comprising 98,255½ statute acres, of which 50,025 are in Antrim, and the remainder in the counties of Armagh, Down, and Londonderry. Its greatest depth is 45 feet; and, according to the Ordnance survey, it is 48 feet above the level of the sea at low water. The lower River Bann, which is obstructed by weirs and rocks, being the only outlet for the waters of the lake, the surrounding country is injuriously inundated in winter. The waters of Lough Neagh are supposed to possess petrifying powers, but it is probable that these exist in the soil, as petrifactions are only found in the lake near the shore, and are also found at considerable heights inland. It is connected with Belfast, Newry, and Coal Island by means of canals. North of Lough Neagh, and connected with it by a narrow channel, is Lough Beg or "the small lake," containing 3145 acres, partly in the county of Antrim. This lake is generally 15 feet lower than Lough Neagh, and contains 4 small islands, one of which, Ram Island, belongs to Antrim. Its banks are more diversified and pleasing than those of Lough Neagh, which, owing to the want of wood, are monotonous.

Antrim.

The Rivers Bann and Lagan, both of which rise in the county of Down and form the southern and western boundaries of the county of Antrim, are the only rivers of importance. The rivers strictly belonging to the county, none of whch are navigable, mostly rise in the mountains near the coast, and run into Lough Neagh. They are generally rapid streams, peculiarly valuable as furnishing water-power for turning the numerous corn, flour, and cotton mills established on their banks. Surrounded by a wild and troubled sea, about 7 miles from the northern coast off Ballycastle, lies the Island of Rathlin, 6½ miles in length and 1½ in breadth, of similar basaltic and limestone formation with the mainland in that district. It contains 3399 acres, one-fourth of which is arable, and in 1851 was inhabited by 783 persons, inhabiting 130 dwellings. On the northern coast of the island are some vestiges of a castle, said to have afforded refuge in 1306 to Robert Bruce, who, according to the legend, learned in this place a lesson of indomitable perseverance under difficulties, whilst observing the continued exertions of a spider in the construction of its web.

The county of Antrim is of exceeding interest to the geologist, both on account of its peculiar character, and because the arrangement and alternations of strata are so openly disclosed as to enable the geologist to observe the secrets of nature more closely than can be done elsewhere. The peculiarities of the county are the basaltic pillars, the whin-dikes, stupendous walls which cut through the precipices, and without much intermission, line the coast for a length of nearly sixty Irish miles, the basaltic hummocks, generally stratified, scattered over the face of the county, and of various magnitudes, from the gigantic mountain to the most diminutive hillock.

Besides basalt, there are found limestone, gypsum, coal, surturbrand or fossil wood, freestone, and marble. Chalk is not met with in any other part of Ireland. The fossil wood, or wood-coal, in most places, as at Ballintoy and Killymorris, is covered with columns of basalt. In burning it emits a disagreeable smell, resembling that of rotten wood. Notwithstanding the compressed state in which it is found, the bark and knots are quite distinct, and the rings denoting the annual growth of the wood may be counted. In some instances the roots of the trees may be traced. Their heads all lie to the east, and seem as if laid down by a storm. The Antrim coal district is situated in the northern extremity of the county; and in point of geological position, is remarkable from its association with the great basaltic mass which forms the characteristic of the neighbouring scenery, and differs from all the other coal districts in Ireland, as wanting

the underlying limestone, and resting directly on mica slate. The district extends to the west and south of the magnificent promontory of Fair Head, from Ballycastle to Murlough Bay. The workings at the Ballycastle collieries are probably the oldest in the kingdom. Dr Hamilton, in his letters on the north coast of the county of Antrim, relates that, in 1770, the miners accidentally discovered a passage cut through the rock. It was very narrow, owing to incrustations formed on its sides. On being sufficiently widened, some workmen went through it, and on minute examination this subterranean wonder was found to be a complete gallery which had been driven forward many hundred yards into the bed of coal, branching out into thirty-six chambers, dressed quite square, and in a workmanlike manner. Some remains of the tools, and even of the baskets used in the work were discovered, but in such a decayed state, that on being touched they fell to pieces. No tradition remaining in the neighbourhood of the mine having been anciently worked, the excavation must have been made at a very remote period.

The coal of some of the beds is bituminous, and of others anthracitous, but the quantity now remaining in the district is very small. Petrifactions are found in Lough Neagh, and valuable hones are made of the petrified wood. In the white sand on the shores of the lake are found very hard and beautiful stones, chiefly chalcedony, known by the name of Lough Neagh peebles, susceptible of a fine polish, and often converted into seals and necklaces.

Besides the fish usually found in fresh-water lakes, the char, a species of trout called dollagher, and the pullan, or fresh-water herring, are found in Lough Neagh, and swans, teals, widgeons, herons, bitterns, and several other kinds of birds frequent its shores.

The mineral waters of the county are in the neighbourhood of Antrim, Ballycastle, Belfast, Carrickfergus, and Larne, and may be generally described as chalybeates of various degrees of strength. No thermal springs have yet been discovered; a circumstance the more remarkable, as it is in the vicinity of basaltic or volcanic rocks that thermal waters are most frequently met with. There are thick beds of rock-salt and salt-springs near Carrickfergus. The chief bathing-places are Ballycastle, Cushendall, Cushendun, Glenarm, Port Ballintrae and Portrush. They are exposed to the easterly winds prevalent in spring, but are desirable summer residences. There is much variety of scenery in the county from the low and somewhat monotonous shores of Lough Neagh and the dreary bog and mountain land of the interior, to the wild romantic scenery of the northern coast, and the fantastically beautiful shores about Glenarm. The climate of Antrim is very temperate, and less rain falls than is generally supposed. The rain gauge at Belfast has varied in different years from 20 to 35 inches. The greatest height of the barometer between the year 1796 and 1809 was 31 inches, the lowest 28 inches. The greatest height of the thermometer during that period was 78·80, the lowest 25. The mean temperature of Belfast is about 50 degrees, or one degree higher than that of London. The phenomenon of the mirage, similar to the *Fata Morgana*, is often observed in the strait which separates the island of Rathlin from the mainland.

In 1712 the number of dwelling-houses in the county of Antrim was 19,268; in 1726, 18,916; in 1791 the number was 30,314, of which 22,353 paid the tax for one hearth, and the remainder were returned as inhabited by paupers unable to pay. According to the population returns, the county contained in 1813, 42,258 dwelling-houses and 231,548 inhabitants; in 1821, 270,883; in 1831, 325,615; in 1841, 354,153; and in 1851, 352,264, inhabiting 58,281 houses, being a decrease of 1889 persons, and 1084 houses since 1841.

The estates in Antrim are in general freehold, being either immediate grants from the crown, or held under those grants: the only exceptions are the properties held under the see of Connor. Some of the estates are very large. The Marquises of Hertford and Donegal, and the Antrim family, possess the fee of the greater part of the county. The estate of the first includes 11 parishes, containing nearly 80,000 English acres. The other chief proprietors are Lord O'Neill, Viscount Massereene, Captain Packenham, and Lord Templetown. The estate of the last is only leasehold under the Marquis of Donegal.

The farms in Antrim are usually small, but, as in other parts in Ireland, the number of small holdings has for several years been steadily on the decrease. In 1851 there were 395 holdings not exceeding 1 acre; 2443 above 1 and not exceeding 5 acres; 6996 between 5 and 15 acres; 7220 between 15 and 30 acres; and 5796 above 30 acres, making a total of 22,850 holdings, being 361 less than in the previous year.

The principal feature in the tillage system of a great part of the county is the potato fallow. The quantity of potato land is commonly regulated by the manure that can be collected: of late years the culture of potatoes has been much increased by the use of lime. After potatoes, wheat or oats are sown; if the latter, two or three crops are successively taken. When the ground is exhausted, potatoes are again planted, or the land is suffered to rest for a year or two, until it is covered with natural grass, in which state it is termed *lea*. The sowing of wheat is chiefly confined to the baronies of Belfast, Antrim, and Massereene.

Flax is also sown after potatoes, except in the lower or northern part of the county, and its cultivation is largely on the increase, although it still forms but a small proportion in the general crop. In 1847 the land in the county under the flax crop was 2516 acres, and in 1851, 11,912. The cultivation of wheat, oats, and barley is decreasing, whilst the culture of potatoes and other green crops, meadow and clover land and flax, increases annually. The export of flax from Belfast was in 1850, 1457 tons; in 1851, 4001 tons, and in 1852, 6258 tons, whilst the import of foreign flax has decreased owing to the greatly increased cultivation of flax in Ireland. The extent of land under crops in 1847 was 202,888 acres, and in 1851, 227,453 acres, being an increase of 12 per cent. in four years. In 1851 the number of acres under the several species of crop was as follows:—wheat, 9938; oats, 98,594; barley, 1397; beans, 4614; potatoes, 41,013; turnips, 13,302; mangel-wurzel, and other green crops not previously enumerated 2806; flax, 11,912; meadow and clover, 52,272. The total produce of corn, beans, and pease in 1851 was 78,779 tons, being a decrease of 17,123 tons since 1847; and the number of barrels of potatoes grown in 1851 amounted to 1,746,510, being the largest quantity produced in any county in Ireland excepting the four counties of Cork, Down, Mayo, and Tipperary. The minute subdivision of the land somewhat retards the progress of improvement in agriculture and agricultural implements.

There is now but little natural wood in the county. The woods of Portmore and Glenarm have long since yielded to the axe; and the extensive plantings at Antrim, Templepatrick, Ballyclare, and Clementshill, have shared a similar fate. Many thriving plantations of trees have, however, been planted of late years near noblemen and gentlemen's seats, which already add much to the appearance of the face of the country. The plantations of Lord O'Neill at Shanescastle and Claggan, and those of the late Lord Macartney near Lochguile, are the most extensive. On the Hertford estate, near Lough Neagh, many orchards are planted.

The cattle of Antrim have no feature to distinguish them

as being allied to any particular stock. Of late years, considerable attention has been paid by gentlemen farmers to the improvement of the breed, by crossing with the Dutch, Leicester, and Ayrshire cattle, which is said to have improved much those kept for milk, and large quantities of butter are annually exported from Belfast. Sheep are little attended to, and are mostly of an inferior kind. Few goats are kept, and those chiefly by cottagers. Pigs are reared and kept in considerable numbers, and on these the small farmers and cotters depend chiefly to make up their rents; so that it is not uncommon to find from two to eight or ten of these animals about a farmer's house. During the salting season, which may be said to commence in September and end in May, the number brought to market is very large. In 1851, the live-stock in the county consisted of 27,673 horses, 450 mules and asses, 131,818 cattle, 42,361 sheep, 43,528 pigs, 1054 deer, 1609 goats, and 237,059 poultry, of the total value of L.1,186,762.

Antrim has long been distinguished for its linen manufacture, which may still be considered the staple manufacture of the county. It is a peculiarity of this occupation that it does not remove the peasant from the comforts and healthiness of rural life. In Antrim the weaver and the labourer of the soil are united in the same person. Many weavers have small farms, and only employ themselves in weaving during the intervals of their farming occupations; and almost all who pursue this occupation possess gardens and ground for potatoes. Formerly the wages for weaving a fine web varied from 14s. to 20s., but the rate is now much less, and consequently many weavers have become day labourers. The price of linen yarn, which formerly sold at 10d. or 1s. per hank, is now much reduced. This is in a great measure owing to the spinning of flax by machinery, which of late years has much increased. In 1841 there were about 240,000 spindles in operation, and now upwards of 500,000 are employed. The quantity of linen yarn exported from Belfast in 1852 was 6,679,680 lb. in 5963 bales, being an increase of 1962 or 2,185,440 lb. over the quantity exported in 1850.

Cotton spinning by jennies was first introduced in 1777, by Robert Joy and Thomas M'Cabe of Belfast, under the direction of a female spinner from Glasgow, and in 1800 it was computed that upwards of 13,000 people were directly employed in the cotton manufacture, and including others indirectly employed, the number was estimated at 27,000, within a circuit of ten miles, comprehending the towns of Belfast, Lisburn, and Carrickfergus. For many years after the introduction of the trade, the greater part of the yarn used for warps, and much of the weft yarn, was imported from Manchester or Scotland, but of late years cotton yarn has been exported from Belfast. The cotton manufacture has not increased of late years in Antrim.

A great source of employment for females has latterly sprung up in the working of patterns on muslin with the needle. Belfast is the centre of this trade, but large numbers of females are employed in various parts of Ireland in the production of these sewed muslins, and the gross value of the goods, when manufactured, amounts to about L.1,400,000. There are also extensive paper-mills in the county, and various manufactures in connection with the trade of the district. The exports are linen, linen yarn, all kinds of grain, pork, bacon, hams, beef, butter, eggs, lard, potatoes, soap, and candles.

There are extensive salmon-fisheries at Carrick-a-Rede, near Balintoy, along the coast north of Glenarm, and in the Rivers Bann and Bush. These fish frequent the other rivers of the county except the Lagan. All the rivers abound with eels, which are chiefly taken at weirs in the River Bann, where they are very plentiful.

Antrim has been supposed to contain a greater proportion of Protestants than any other county in Ireland; and of the Protestants a very great proportion are Presbyterians. The greater part of these are in connection with the general Synod of Ulster, the others are *Remonstrants*, who separated from the Synod in 1829—United Presbyterians, Covenanters, Independents; and at Gracehill, near Ballymena, there is a Moravian settlement. In several parishes, however, a decided majority are Roman Catholics.

The number of children attending schools in 1841 was, in rudimental schools, males 9737, females, 7743; in superior schools, males, 794, females, 448; total, 18,722. In 1851 there were 339 national schools in operation, attended by 28,763 children, 15,746 males, and 13,017 females. The educational establishments in Belfast are numerous and well conducted, including the Belfast Academy, the Royal Academical Institution, the Lancasterian or Ragged Schools, the National Schools, the Ulster Institution for the Deaf and Dumb and the Blind, the Educational and Industrial School, the Queen's College, and the Government School of Design.

The character of the people of Antrim reveals their Scottish origin. They have not the devotion to pleasure and sociality which is observable in other portions of the island, wanting in consequence some of the southern polish, but compensating in depth and solidity for any deficiency in superficial qualities.

Antrim, a town of Ireland, in the county of the same name, situated half a mile from Lough Neagh, on the banks of the Six-mile-water, in one of the most fertile and beautiful valleys of the county, 13 miles north-west of Belfast, and 106 north of Dublin. It gives the title of earl to the noble family of MacDonnell, and prior to the Union was a potwalloping borough, returning two members to Parliament by virtue of letters patent, granted to the inhabitants in 1666, by Charles II. It was under the patronage of the Skeffington family.

Although much improved of late years, there is nothing in the town particularly worthy of notice; but the environs, including Shane's castle and the grounds of Massareene castle, possess considerable interest. About a mile from the town, surrounded by wood, above which rises its gray conical head, is one of the most perfect of the round towers of Ireland. It is 95 feet high, and 49 in circumference at the base. Markets are held each Tuesday and Thursday, and fairs on January 1, May 12, and November 12. In 1851 the town contained 504 dwelling-houses, and 2324 inhabitants. The manufacture of paper has been carried on here for many years, and there are flour and meal mills near the town. The Belfast and Ballymena railway passes a short distance from the north of the town. On the 7th of June 1798 a smart action was fought in the town between the king's troops and a large body of rebels, in which the latter were defeated. In this action Lord O'Neill was mortally wounded by a pike. (H. S—R.)

ANTWERP (in French, Anvers), one of the provinces of the kingdom of Belgium, is bounded on the north by North Brabant, on the east by Limburg, on the south by South Brabant, and on the west by Zealand and East Flanders. It contains 824 geographical square miles, or 283,311 hectares, equal to 770,924 English imperial acres, and is divided into 3 arrondissements, 22 cantons, and 146 communes. The province is an extensive plain scarcely diversified by an elevation. The arable land, which contains a great proportion of sand, is very fertile, but a considerable part of the country is morass and heath, particularly in the north and east. The population in the beginning of 1851 amounted to 420,556.

Antwerp, one of the three arrondissements of the above

province, comprehends 7 cantons and 57 communes. In 1851 it had a population of 199,891.

Antwerp, the capital of the above arrondissement and province, is situated on the right bank of the river Schelde, 26 miles north of Brussels, in Lat. 51. 13. 16. N. Long. 4. 24. 10. E. The city is well built, in the form of a crescent, containing many fine streets and squares, and is fortified. The houses are large and handsome, and some of its public buildings are of great splendour and antiquity. The citadel, a strong pentagonal structure, was built by the Duke of Alva in 1567, and is celebrated in recent times for the defence made here by General Chassè in the end of the year 1832. One of the most beautiful specimens of Gothic architecture in the Netherlands is the cathedral of Notre Dame, founded in the early part of the fifteenth century, but not finished till the sixteenth: it is 500 feet long, 250 feet wide, and has a spire 403 feet high. Nor is the interior inferior in grandeur to the exterior; besides other pictures it possesses several by Rubens, one of which is the celebrated "Descent from the Cross." The church of St James is also very splendid in its internal decorations of marbles, painted glass, carved wood, and monuments. Behind the high altar, and covered by a slab of white marble, is the tomb of Rubens, by whom the "Holy Family" which adorns the altar was painted. Sir Joshua Reynolds observes, that for effect of colour this picture yields to none of Rubens's works. The churches of St Paul, St Andrew, and St Augustine, likewise contain some fine paintings by Rubens and others of the old masters. The exchange, built in 1531, is one of the finest buildings of the kind in Europe; and is said to have been chosen by Sir Thomas Gresham as a model for the Royal Exchange in London. The town-house is a handsome edifice in the Italian style, and exhibits the five orders of architecture, one over the other. Antwerp contains many educational and literary institutions. It has a Royal Athenæum, in which most of the usual branches of literature and science are taught, a higher school, schools of navigation, medicine, and surgery, a botanic garden, a public library, and various scientific and literary societies. It has also a Royal Academy of the Fine Arts, which affords gratuitous instruction in painting, sculpture, architecture, and engraving. At the competition which takes place in one of these arts annually, the laureate receives a pension of 2500 francs for four years, to enable him to pursue his studies in Germany, France, and Italy. The second prize is a gold medal of the value of 300 francs. Among the numerous works in the Academy of Painting, are 12 or 14 fine pictures by Rubens, 6 by Vandyck, and several by Titian, Teniers, Jordaens, Quentin Matsys, and other masters. The charitable institutions include a foundation for foundlings, besides several other hospitals and asylums, courts of assize, commerce, &c.

Antwerp enjoys many facilities for commerce. The Schelde at this point is about 2200 feet broad, with a depth of from 30 to 40 feet at ebb tide, and a rise at spring tides of from 12 to 14 feet; and as this depth increases towards the sea, the largest vessels can, by means of the canals, come up to the wharfs. The advantageous situation of Antwerp did not escape the penetrating eye of Napoleon, who spared no labour or expense to render it the rival of London in commerce, and of Portsmouth as a military establishment. The sums expended by him for this purpose are said to have amounted to L.2,000,000 sterling, which he declared to be nothing to what he intended. On the downfall of Napoleon, the dockyard, with its fortifications, was destroyed; but two large basins on the north side of the town, of the respective areas of 17 and 7 English acres, have been preserved. They are capable of admitting ships of the line; and as commercial docks they are now of the greatest service to trade and navigation. The junction of this city with Brussels by a railway, which was opened in 1836, has been of great advantage to both cities. In 1850 the number of ships that entered its harbour was 1406, of the aggregate burthen of 233,760 tons; and the number that left the port was 1456, with the gross burden of 242,884 tons. The imports are principally coffee, grain, seeds, raw sugar, cotton, tobacco, and colonial produce; the exports are flax, woollen goods, refined sugar, metals, glass, and tallow. It has regular steam-communication with London and Hull.

The manufactures of Antwerp are various and considerable, the principal being lace, silk, linen, cotton, tapestry, galloon, twine, sugar, white lead, litmus, starch, printers' ink, and malt liquors. The lapidaries of Antwerp are celebrated for their skill in cutting diamonds. The shipbuilding is considerable, and the timber used for that purpose is principally brought by water from the interior. The National Bank of Belgium has a branch here.

Antwerp, according to the general census of 15th October 1846, contained 13,626 houses, and 88,487 inhabitants, of whom 85,961 were Roman Catholics, 1312 Protestants, and the remainder either Jews, or belonging to other sects. The greater number of the inhabitants speak Flemish or Dutch. According to the above census 81,947 spoke Flemish or Dutch, and 3915 French, or Walloon. The number of births during the year 1850 was 3250, of whom 144 were still-born; the deaths amounted to 1914; and the population, in the beginning of 1851, was 95,501.

The present commercial condition and importance of Antwerp is far inferior to what it was several centuries ago. About the end of the fifteenth century it was the richest and most flourishing city in Europe. No fewer than 500 ships would sometimes enter the port in one day, and as many as 2500 vessels might be seen lying in the river at one time. On an average, 500 waggons laden with goods daily entered its gates; and above 500,000,000 of guilders were annually put in circulation. It had then 200,000 inhabitants; and indeed all that is said of its commercial prosperity and the immense riches of its merchants, is almost incredible. The first blow to its prosperity was its capture by the Spaniards in 1576, when it was plundered for three days; and nine years afterwards, when besieged and ultimately captured by the Spaniards under the Duke of Parma, its trade was utterly ruined. After this event the greater number of its merchants and principal inhabitants removed to Amsterdam or other places. The Dutch, with the view to lessen the importance of a place which had now fallen into the hands of their enemies, built ports on the river in order to intercept such vessels as might attempt to get to Antwerp. By the terms of the peace of Westphalia in 1648, the commerce of its harbour was closed. In 1794 it fell into the hands of the French, who opened its port, and made it the capital of the department of the two Nethes. It remained in their possession till 1814, when it was surrendered, after the treaty of Paris, by Carnot, who up to this time had defended it with great spirit and bravery against the allied army under the command of Graham. From 1815 to 1830, Antwerp, with the rest of Belgium, united with Holland to form the kingdom of the Netherlands; and during this period its commerce increased so rapidly as to excite the jealousy of Amsterdam. For the part which Antwerp bore in the revolution of 1830, which dissolved the union between Holland and Belgium, see Netherlands.

Among the distinguished natives of the place are Vandyck, the two Teniers, Jordaens, Floris, the geographer Ortelius, and the engraver Edelinck. Here Rubens also, though not a native, received his education, and resided.

ANUBIS, a symbolical deity of the Egyptians, was re-

garded as the faithful companion of Osiris and of Isis. Temples and priests were consecrated to him, and his image was borne in all religious ceremonies. Cynopolis, situated in the Lower Thebais, was built in honour of Anubis. The temple in which he was worshipped, and where his festivals were celebrated with great pomp by the priests, no longer exists. The dog was consecrated to him as his living representative; and a number of these animals were kept in the temple, and fed upon sacred aliment. Strabo, in his 17th Book, speaks of the worship of Anubis in the Cynopolitan nome and city, "where honour and a certain sacred food is allotted to dogs." An event, however, related by Plutarch, brought them into considerable discredit with the people:—Cambyses having slain the god Apis, and thrown his body into a field, all animals respected it except these, which alone ate of his flesh. Recent investigation, and the study of Egyptian sculptures, seem to prove that the head on the human shoulders of Anubis are not those of any domestic dog, but of the jackal.—See Wilkinson's *Egypt*. Anubis was recognised by the Greeks as a character of Hermes.

Cynopolis was not the only city which burned incense on the altars of Anubis. He had chapels in almost all the temples. In solemnities, his image always accompanied those of Isis and Osiris. Rome having adopted the ceremonies of Egypt, the Emperor Commodus, to celebrate the Isiac feasts, shaved his head, and himself carried the god Anubis. The statue of this god was either of massive gold or gilt, as well as the attributes that accompanied him. Anubis signifies *gilded*. The denomination was mysterious; and the Egyptian priests, it would seem, had not given it without reason.

The signification of this emblematical deity is thus explained by Plutarch: "The circle which touches and separates the two hemispheres, and which is the cause of this division, receiving the name of *horizon*, is called *Anubis*. He is represented under the form of a dog, because that animal watches day and night." Clemens of Alexandria, who was well informed in the mystic theology of the Egyptians, favours this explanation. "The two dogs," says that writer, "are the symbols of two hemispheres which environ the terrestrial globe." He adds in another place,—"others pretend that these animals, the faithful guardians of men, indicate the tropics, which guard the sun on the south and on the north, like porters."

According to the former of these interpretations the priests, regarding Anubis as the horizon, gilded his statue, to mark that this circle, receiving the first rays of the sun, appears sparkling with brightness on his rising, and that at his setting he reflects his last rays upon the earth. They said, in their sacred fables, that Anubis was the son of Osiris, but illegitimate. In fact, he only gives to the earth a borrowed light, and cannot be esteemed, like Horus, as the father of the day, or as the legitimate offspring of Osiris. It may be added, that the visible horizon, turning with the sun, is his inseparable companion.

In the latter of these explanations, where Anubis represents the tropics, he is also the faithful guardian of Isis and Osiris. In fact, the course of the sun and of the moon is contained between the circles wherein the solstices are performed. They deviate neither to the right nor left. These limits, assigned by the Author of nature, might therefore, in hieroglyphic language, be represented by a divinity with the head of a dog, who seemed to oppose the passage on the side of the two poles. The other opinion, notwithstanding, seems more natural, and more analogous to the ideas of the priests.

Upon the whole, it is reasonable to imagine that Anubis at first was only a symbolical image, invented by astronomers to give a sensible expression of their discoveries; that afterwards the people, accustomed to see it in their temples, which were the depositories of science, adored it as a deity; and that the priests favoured their ignorance by connecting it with their religion. The worship of Anubis being introduced, the dog became his emblem. Almost all the gods of the Gentiles have originated in this manner.

ANVIL, in *Smithery*, and other manufactures of the malleable metals, is an instrument on which substances are laid for the purpose of being hammered.

For some purposes anvils are made of cast iron; but when the face of the anvil is required to possess great hardness, or a bright surface, it is made of wrought iron and faced with steel. The core or body of wrought-iron anvils is prepared at the forge, where malleable iron is first formed into bars, or into masses for any particular purpose. The body of the anvil is formed by welding a number of smaller masses together under the forge-hammer. These are rude blocks of different sizes, according to the size of the anvil. Smaller masses are also furnished in this way, which the anvil-maker occasionally welds to the large blocks, for giving to the anvil any particular form.

The fire-place or hearth of the anvil-maker's forge is similar to the common smith's forge. His bellows are not double, like the latter. His fuel is cork, which produces a great heat without much flame. Adjacent to the hearth is a crane, which, turning upon a pivot, brings the heated masses of iron from the fire to the anvil. The latter is a large mass of cast metal, about 18 inches square on the face, and about a foot from the ground. When the core of the anvil to be formed is heated, the first thing is to make three square holes, one in the bottom, and one at each end of the anvil. These holes are about $1\frac{1}{4}$ inch long, 1 inch broad, and about 2 inches deep. They are for the purpose of receiving a bar of iron, which is connected with the crane by which the anvil is held in the fire, and by which it is turned and guided while forming with the hammers.

The common smith's anvil is generally made of seven pieces, namely, the core or body; the four corners, for the purpose of enlarging its base; the projecting end, which contains a square hole, for the reception of a set, or chisel, to cut off pieces of iron; and the seventh piece is the beak, or conical end, used for turning pieces of iron into a circular form, welding hoops, &c. These pieces are each separately welded to the core, and hammered so as to form a regular surface with the whole. When large pieces are required to be welded to the core, one fire is not sufficient to heat both at the same time. In this case two hearths are employed. The core and the piece are both raised to a welding heat. The piece being put into its place, is hammered by a quick succession of blows till it adheres. The whole is again heated and hammered till the due form is obtained. The hammering is performed by a number of men at the same time, each using a large swing-hammer. The blows follow each other in regular succession, great experience and care being required to prevent the hammers from coming in contact with each other.

When the anvil has received its due form, it then requires to be faced with steel. This is performed by first preparing the steel face to the size of the anvil. The anvil is then heated to a strong welding heat in one fire, while the steel facing is heated in another, but not so hot as the iron. The anvil is now brought out and placed in a proper position, and the facing is brought to it. The surfaces which are to be brought together are brushed, and the facing is then laid on and hammered as rapidly as possible, till it is closely united. The whole is finished by repeated heating and hammering.

The next process is that of hardening the anvil. This consists in heating the face, in particular, to a full red heat, and quenching it in cold water. When a stream of water

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can be employed it is better. Where this cannot be had, the mass of water should be great, and the anvil moved about as quickly as possible. The facing should be laid on as thin as it can be firmly welded; when it is too thick it is apt to crack in the hardening.

After hardening, the face is ground till it is perfectly even, and the edges made sharp or round, as may be required. When the anvil is required for planishing metals, it is polished with emery, and afterwards with crocus.

The smith's anvil is generally placed loose upon a wooden block, the root-end of an oak-tree being preferred. The anvils used in cutlery and for files are fastened into a large block of stone, which is doubtless better than having the anvil loose upon a small block. The more firmly the anvil is connected with the earth and the substances it stands upon, the greater will be the effect of the blow of the hammer. (C. S—R.)

ANVILLE, Jean Baptiste Bourguignon d', a French geographer of the highest eminence, and perhaps unsurpassed in any age. This celebrated man was born at Paris on the 11th of July 1697. His passion for geographical research displayed itself from his earliest years. At the age of 12, while reading the Latin authors at college, he amused himself with drawing maps of the countries which they described. While he was thus busily employing himself one day in the class, his master observed and was about to punish him; but upon casting his eye upon the performance, he immediately judged him to be rather deserving of encouragement. D'Anville from this time devoted himself entirely to geography, particularly that of the ancient world; and at the age of 22 he began to delineate maps which attracted the attention of the most eminent geographers.

There are two modes by which problems in geography may be solved; one mathematically, by astronomical observation or geometrical measurement; the other historically, by the distances of places inferred from the narrative of historians and travellers. The former is certainly the most satisfactory, and would supersede every other, could it be extended over the whole surface of the globe. But, notwithstanding the splendid progress made since the era of D'Anville, it is still far from such a degree of perfection. In all countries the bulk of the positions must be filled up, and in some the whole must be constructed from mere historical materials. Perhaps there is no department of science which requires greater extent of knowledge and accuracy of judgment. The variety of sources out of which the materials must be drawn is almost infinite; and their application is equally nice and difficult. It must be regulated by a complete acquaintance with all the modes of measurement used by all nations; by a careful notice of those errors and contradictions which naturally arise from a partial and limited observation; and by the marking of certain delicate processes in the human mind, by which space and distance are sometimes diminished, and more frequently exaggerated. In the skilful geographer, sound natural judgment, enlightened by experience, creates, as it were, a new sense, which enables him to see consistency amid a labyrinth of contradictions, and to elicit truth from a multitude of statements that are all erroneous. This art may be said to have originated with D'Anville, and to have been brought by him to its highest perfection.

The course of study on which D'Anville entered was truly immense. Works professedly geographical formed the least part of it; those of all the ancient and modern historians, travellers, narrators of every description, were assiduously examined. He studied, but only for the sake of the occasional geographical lights which they afforded, the philosophers, orators, and poets; for it was remarked that in perusing these masterpieces of human genius, he was totally indifferent to everything which did not tend to fix a geographical position. The object of this immense labour was to effect a complete reform in the science of geography; to banish the system of copying blindly from preceding maps, and never to fix a single position without a careful examination of all the authorities upon which it rested. By this process he detected many and great errors in the works of his most celebrated predecessors, while his own accuracy was soon attested on all sides by the travellers and mariners who had taken his works as their guide. His principles led him also to another innovation, which was that of omitting every name for which there existed no sufficient authority. The public were at first amazed at seeing vast spaces, which had before been covered with countries and cities, suddenly reduced to a perfect blank; but they soon recognised that this was the only accurate course, and that the defect lay in the science, not in the geographer.

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D'Anville was at first employed in the humbler task of illustrating by maps the works of different travellers, such as Marchais, Charlevoix, Labat, and Duhalde. The question respecting the figure of the earth coming to be much agitated, he published, in 1735 and 1736, two treatises, with a view to illustrate it. But this attempt to solve a geometrical problem by historical materials was eminently unsuccessful. Maupertius having gone to measure a degree within the polar circle, the result was found directly opposite to our geographer's prediction. This, however, was considered by the intelligent public rather as fixing limits to his mode of investigation, than as implying any want of diligence and ability in its employment.

Any loss of reputation which this failure might occasion was completely retrieved by his map of Italy, published in 1743. It was marked by a species of investigation often employed by D'Anville with peculiar success. This consisted in the application of ancient materials to correct the existing geography. By the diligent study of the Latin authors he was enabled to trace numerous errors which had crept into the delineation of this interesting country. A trigonometrical survey which Pope Benedict XIV. almost immediately after caused to be made in the Ecclesiastical States confirmed, in a surprising degree, all these alterations. On this occasion he first set the example, which cannot be too much applauded, of accompanying the map with a memoir exhibiting a view of the data on which it had been constructed.

He now applied himself to ancient geography, always his favourite department, and the aspect of which, under his hands, was soon completely changed. He illustrated successively, by maps, all the countries known to the ancients, among which Egypt attracted his peculiar attention. To render these labours more extensively useful, he published in 1768 an *Abridgment of Ancient Geography*. His attention was finally turned to the middle ages, which were illustrated by his *States formed in Europe after the fall of the Western Empire*, and by some other works equally learned. Entirely devoted to geographical inquiries, the appearance of his successive publications formed the only events by which his life was diversified. From causes which are not explained, he was late in being admitted into the literary societies. In 1754, at the age of 60, he became a member of the Academy of Inscriptions and Belles Lettres, whose transactions he enriched with many papers. In 1775 he received the only place in the Academy of Sciences which is allotted to geography; and in the same year he was appointed, without solicitation, first geographer to the king. But these honours came too late to gladden a life which was now drawing to its utmost verge. His last employment consisted in arranging his collection of maps, plans, and geographical materials. It was the most extensive in

Europe, and had been purchased by the king, who, however, left him the use of it during his life. This task performed, he sunk into a total imbecility both of mind and body, which continued for two years, and ended only with his death in January 1782, when he had nearly reached the great age of 85.

D'Anville, with the qualities which form the great geographer, united all the essentials of an honourable and worthy character. The advancement of the science to which he had devoted himself formed almost the sole passion of his life; and, mingling little with society, he contracted peculiarities which solitary study is but too apt to engender. He talked with little interest on any subject except geography. This topic necessarily led to that of his own discoveries, on which he was never weary of expatiating. He boasted without any reserve of the services which he had rendered to that science, using not unfrequently the expression of Augustus, "I found it of brick and left it of marble." He, however, did full justice to the merit of those who excelled in other branches of knowledge; and to such as furnished him with materials for his researches his gratitude was unbounded. His published memoirs and dissertations amounted to 78, and his maps to 211. (H. M.)

ANWARI, a very eminent Persian poet, born of poor parents in Khorassan early in the twelfth century. He enjoyed the especial favour of the Sultan Sandjar, whom he attended in all his warlike expeditions. On one occasion, when the sultan was besieging a rebellious vassal in the fortress of Hazarasp, a fierce poetical conflict was maintained between Anwari and his old rival Rasheedi the poet, who was an inmate of the beleaguered castle, by means of verses fastened to arrows. Anwari died at Balkh in the year 1200. He is considered as one of the best and purest of the Persian poets. His chief work, *The Tears of Khorassan*, has been translated into English verse by Captain Kirkpatrick, in the *Asiatic Miscellany*.

ANWEILER, or Annweiler, the capital of the canton of the same name, in the district of Landau in Rhenish Bavaria. Population 2800, employed in various manufactures. Near it are the ruins of the castle of Triefels, where, under the French emperors of Germany, the crown jewels were kept, and where our Richard Cœur de Lion, in 1193, was detained as a prisoner. Lat. 49. 13. N. Long. 8. E.

ANZIN, a village of France, department of Nord, close to Valenciennes. Its coal mines, which are the most extensive in France, were discovered in 1734, and gave employment to 16,000 persons. It has also several iron foundries and glass works. Pop. in 1846, 3132.

AORIST, from α, priv., and ὅρος, a boundary, in *Grammar*, a tense peculiar to the Greek language, expressing action in an indeterminate manner, without any regard to past, present, or future.

AORISTIA, in the *Sceptic Philosophy*, denotes that state of the mind wherein we neither assert nor deny anything positively, but only speak of things as seeming or appearing to us in such a manner. The aoristia is one of the great points of scepticism to which the philosophers of that denomination had continual recourse by way of explication or subterfuge. Their adversaries the dogmatists charged them with dogmatizing, and asserting the principles and positions of their sect to be true and certain.

AOSTA, formerly a duchy of Piedmont, but now a province of the kingdom of Sardinia, lying south of Valais and east of Savoy. It has an area of 1025 geographical square miles, and in 1848 contained 81,232 inhabitants. The country is in general mountainous; but there are several valleys of great extent, particularly the *Val d'Aosta*. By the industry of the inhabitants these low grounds are very fruitful in wine, oil, and pasture; and the mountains abound in iron and copper.

Aosta, the chief town of the foregoing duchy, and the see of a bishop. It is situated on the river Doria, at the foot of the Alps, where the great commercial roads from Savoy and the Valais to Piedmont, over the Great and Little St Bernard, meet each other. The town, though large, is meanly built. It is remarkable for several monuments of the Romans, and for being the birthplace of Anselm, archbishop of Canterbury. Long. 7. 20. E. Lat. 45. 44. N. Pop. 7120.

APÆDUSIA (α, priv., and παιδεύω, I instruct), denotes ignorance or unskilfulness in what relates to learning and the sciences. Hence also persons uninstructed and illiterate are called *apædeutæ*. The term *apædeutæ* was particularly used among the French in the time of Huet, when the men of wit at Paris were divided into two factions, one called by way of reproach *apædeutæ*, and the other *eruditi*. The *apædeutæ* are represented by Huet as persons who, finding themselves either incapable or unwilling to undergo a severe course of study in order to become truly learned, conspire to decry learning, and turn the knowledge of antiquity into ridicule, thus making a merit of their own incapacity. The *apædeutæ* in fact were the men of pleasure, the *eruditi* the men of study. The *apædeutæ* in everything preferred the modern writers to the ancient, to supersede the necessity of studying the latter. The *eruditi* derided the moderns, and valued themselves wholly on their acquaintance with the ancients.

APAGOGE, in *Mathematics*, is sometimes used to denote a progress or passage from one proposition to another, when the first, having been once demonstrated, is afterwards employed in the proving of others.

APAGOGICAL Demonstration, an indirect way of proof, by showing the absurdity of the contrary.

APAGON, a genus of fossil fishes, in the Cycloïd Order of Agassiz.

APAGYNOUS (from ἅπαξ and γονή), a term applied to plants that fructify but once. It is the same as *Monocarpic*.

APALACHIAN MOUNTAINS. See Allegany Mountains.

APAMEA, in *Ancient Geography*, the name of several Asiatic cities:—1. A large city of Syria, capital of Apamene, in the valley of the Orontes. In the time of the Crusades, it was called Famieh, and is supposed to be represented by the extensive ruins at Kulat-el-Mudyk. 2. A city on the Tigris, probably near its confluence with the Euphrates, where the modern Korna now stands. 3. In Osroëne, on the left bank of the Euphrates, opposite to Zeugma. 4. The name given to Myrlea of Bithynia, by Prusias I., who rebuilt it. Its ruins lie near Medania. 5. A town of Phrygia, the site of which is fixed at Denair. 6. A Greek city of Parthia, in the district of Choarene.

APANAGE (*Apanagium, Apanamentum*, and probably derived from *panis*, or *panaggio*, provision), lands or feudal superiorities assigned to the younger princes of a reigning family. The apanage descended to the lawful heirs-male; and in their default it reverted to the crown. It was customary for the sons of princes to derive their surnames from the apanage.—See Pasquier's *Recherches*, l. 2, c. 18; l. 8, c. 20. Henault's *Hist. de France*, anno 1283.

APATHY, among the *Ancient Philosophers*, implied an utter privation of passion, and an insensibility of pain. The word is compounded of α, priv., and πάθος, *affection*. The Stoics affected an entire apathy: they considered it as the highest wisdom to enjoy a perfect calmness or tranquillity of mind, incapable of being ruffled by either pleasure or pain. In the first ages of the church the Christians adopted the term *apathy* to express a contempt for all earthly concerns, a state of mortification such as the gospel prescribes. Clemens Alexandrinus, in particular, brought it greatly into use; thinking thereby to draw to Christianity the philosophers who aspired after such a sublime pitch of virtue.

APATITE, a mineral often crystallised in six-sided prisms. It is a phosphate of lime. See MINERALOGY.

APATURIA, in *Antiquity*, a solemn feast celebrated by the Athenians in honour of Bacchus. The word is usually derived from ἀπάτη, *fraud*. It is said to have been instituted in memory of a fraudulent victory obtained by Melanthus of Messenia, over Xanthus, king of Bœotia, in a single combat, which they agreed upon to put an end to a debate between the Athenians and Bœotians respecting their frontiers.

Other authors give a different etymology of this feast. They tell us that the young Athenians were not admitted into the tribes on the third day of the apaturia, till their fathers had first sworn that they were their own children; and that till that time they were supposed in some measure to be without fathers, ἀπάτορες; whence the feast, say they, took its name. Xenophon, on the other hand, informs us that the relations and friends met on this occasion, and joined with the fathers of the young people who were to be received into the tribes; and that from this assembly the feast took its name; that in ἀπατούρια, the α, far from being a privative, being here a conjunctive, signifies the same thing with ἅμα, *together*. This feast lasted three days: the first day those of the same tribe made merry together; and this they called δορπία. The second day, which they called ἀνάρρυσις, they sacrificed to Zeus and Athena. The third day, which they called κουρεῶτις, such of their children as had not been registered were admitted into their tribes. The following day, as in other festivals, was called ἐπίβδα.

APAULIA, in *Greek Antiquity*, the third day of a marriage solemnity. It was thus called because the bride, returning to her father's house, lodged apart from the bridegroom (ἀπαυλίζεσθαι τοῦ νυμφίου). Some will have the apaulia to have been the second day of the marriage, viz., that whereon the chief ceremony was performed; thus called by way of contradistinction from the first day, which was called προαύλια. On the day called ἀπαύλια (whenever that was) the bride presented her bridegroom with a garment called ἀπαυλιστήρια.

APAUMEE, in *Heraldry*, denotes one hand extended with the full palm appearing, and the thumb and fingers at full length.

APE. See MAMMALIA, *Index*.

A-PEAK, in *Seamen's Language*, signifies perpendicular; thus the anchor is said to be a-peak when the stem of the ship is brought directly over it by drawing in the cable.

APEL, or APELLUS, JOHANN, professor of law in the University of Wittemberg, and one of the most zealous partisans of Luther in promoting the Reformation, was born at Nuremberg in 1486. Having married a nun while canon of Warzburg, he published his *Defensio Jo. Apelli pro suo Conjugio; cum præf. Lutheri*, &c. 1523, 4to. His other works are entitled *Methodica Dialectices Ratio, ad Jurisprudentiam accommodata*, Norimb. 1535, 4to: and *Brachylogus Juris Civilis, sive Corpus Legum*, a work much esteemed, and once ascribed to the Emperor Justinian. He died in 1540.

APELLES, the most celebrated painter of antiquity. He was born, according to Ovid and Pliny, in the island of Cos, and flourished in the time of Alexander the Great, whom he probably accompanied in his Asiatic expedition. Alexander gave him a remarkable proof of his regard; for when he employed Apelles to draw Campaspe, one of his mistresses, having found that he had conceived an affection for her, he resigned her to him. Either she, or Phryne, is said to have been the model of his Venus Anadyomene. It is well known that Alexander forbade any one besides Apelles to paint his portrait. We are not, however, to conclude from this that Alexander was a more skilful judge of painting than he was of poetry. Like Augustus, he cherished the fine arts more from vanity than taste. A remarkable proof is given of this prince's inability to discern merit, and of the painter's freedom in expressing the mortification he felt when a work of his was not sufficiently commended. "Alexander," says Ælian, *Var. Hist.*, lib. ii. c. 3., "having viewed the picture of himself at Ephesus, did not praise it as it deserved. But when a horse was brought in, and neighed at seeing the figure of a horse in the picture, *O king!* said Apelles, *this horse seems to be a far better judge of painting than you.*" It is related that on one occasion he had painted a horse returning from battle, and had succeeded to his wishes in describing every other mark that could indicate a mettlesome steed impatient of restraint; there was wanting nothing but a foam of a bloody hue issuing from the mouth. He again and again endeavoured to express this, but his attempts were unsuccessful. At last, in his vexation, he threw against the reins of the horse a sponge tinged with many colours; the mixture of which produced the very effect he had desired.

One of the chief excellencies of Apelles's pictures was their exact resemblance to the originals; but the quality of *grace* was claimed by him as his peculiar characteristic. His pencil was so famous for drawing fine lines, that Protogenes discovered by a single line that Apelles had been at his house. Protogenes lived at Rhodes: Apelles sailed thither, and went to his house with great eagerness to see the works of an artist who was known to him only by name. Protogenes was gone from home, but an old woman was left in charge of a large canvass, which was fitted in a frame for painting. She told Apelles that Protogenes was gone out; and asked him his name, that she might inform her master who had inquired for him. "Tell him," said Apelles, "he was inquired for by this person;" at the same time taking up a pencil, he drew on the canvass a line of great delicacy When Protogenes returned, the old woman acquainted him with what had happened. That artist, upon contemplating the fineness of the stroke, at once pronounced it to be the work of none other than Apelles; but drawing a still finer line of another colour within the first, he ordered the old woman to show that line to Apelles if he came again; and to say, "This is the person for whom you are inquiring." Apelles returned and saw the line: he would not for shame be overcome; and therefore, in a colour different from either of the former, he divided the line of Protogenes by a third so exquisitely delicate as to leave no space for the smallest touch of the pencil. Protogenes now confessed the superiority of Apelles, flew to the harbour in search of him, and resolved to leave the canvass with the lines on it for the astonishment of future artists. It was afterwards carried to Rome and preserved as a most wonderful work of art in the palace of the Cæsars.

Apelles was the first who made the works of Protogenes to be valued as they deserved among the Rhodians. He acknowledged that Protogenes was in some respects superior to himself; but that in one particular he himself excelled, viz., in knowing when to take his hand from the picture, an art which Protogenes had not yet learned, and therefore overworked his pieces. Apelles equally disapproved of too elaborate diligence, or too hasty negligence in execution. A studied work of Protogenes he esteemed less on the one account; and on the other, when a silly painter once brought him a picture, and said, "This I painted in a hurry," he replied, "Though you had not told me so, I perceived it was painted in haste; but I wonder you could not execute more such pieces in the same time."

It was customary with Apelles to expose to public view the works which he had finished, and to hide himself behind the picture, in order to hear the remarks of the passers by. He once overheard himself blamed by a shoemaker for a

fault in the shoes of one of his figures: on the following day the shoemaker, finding the fault corrected, began to animadvert on the leg; upon which Apelles with some anger looked out from behind the canvass, and bade him keep to his own province,—whence the proverb, "Ne sutor ultra crepidam."

The works of Apelles, of which a list is given by Pliny, were all admired; but the most celebrated were the picture of Alexander in the temple of Artemis at Ephesus, and that of Aphrodite emerging from the sea. Alexander was drawn with a thunder-bolt in his hand; and such was the effect produced by the *chiaro-scuro*, that the hand and the thunder-bolt seemed to start out from the canvass. This celebrated picture gave rise to the saying that there were two Alexanders; the one invincible, the son of Philip, the other inimitable, the offspring of Apelles. His Aphrodite Anadyomene, representing the goddess of beauty rising out of the sea, was esteemed the most exquisite figure which ever pencil had created.—(*Pliny*, xxxv. 36, § 10, 11, &c.)

APPELLICON, a native of Teos, who lived at Athens, and is chiefly remarkable for having collected a fine library, in which was then the only extant copy of the works of Aristotle. Sylla purchased this library, and brought it to Rome.—See *Plutarch*.

APELLITES, Christian heretics in the second century, who affirmed that Christ received a body from the four elements, which at his death he rendered back to the world, and so ascended into heaven without a body.

APENNINES, that extensive range of mountains traversing the entire extent of the Italian peninsula, and forming, as it were, the backbone of that country. They detach themselves from the maritime Alps, and pursue a general course, first in an easterly and afterwards in a south-south-easterly direction, till towards their extremity they divide to embrace the Gulf of Taranto. From the main chain numerous branches extend towards the Mediterranean and the Adriatic. This chain is inferior in beauty and grandeur to some of the other mountain ranges of Europe; being destitute of the glaciers and vertical needles of the Alps, the sharp peaks of the Pyrenees, or the rocky cliffs and escarpments of the Jura Mountains. Nowhere do they reach the snow line, though some of their summits are covered with snow during a great part of the year. Their mean height is about 4000, and their highest point, Monte Carno, or *Il gran sasso d'Italia*, the great rock of Italy, is 10,154 feet high; Monte Amaro, the highest point of Monte Majella, is 9131 feet high, and Monte Velino 8207 feet. The chain is little cultivated, and abounds with fine oaks and other kinds of trees; and the valleys are generally small and narrow. Almost all the rivers of Peninsular Italy take their rise in this range, but most of them are, with the exception of the Arno and the Tiber, little more than mountain torrents.

The name Apennines is probably of Celtic origin, and derived from *pen*, properly signifying the head, but also used for the summit of a mountain. By the Greek and Latin writers the name is generally used in the singular, as *Apenninus Mons*, Ὁ Ἀπέννινος, τὸ Ἀπέννινον ὄρος. The name may have been originally applied only to a particular mountain, and have afterwards been extended to include the whole chain.

The Apennines may be considered as a southern branch of the great Alpine system of Europe, and indeed there is no real separation between them; which has caused great differences of opinion among both ancient and modern geographers as to the point where the Alps terminate and the Apennines begin. Strabo, who gives a very accurate account of the general features and direction of this chain, considers it as beginning in the vicinity of Genoa, and in this he is nearly followed by many modern geographers who place its commencement between that town and Savona, in the valley of Bormida. The more natural commencement, however, seems to be at Col de Tenda, in Long. 7. 40. N. From Col de Tenda they run in a semicircle round the Gulf of Genoa in a general direction from west to east; they afterwards turn to the south and traverse the whole of the Italian peninsula to the Strait of Messina. The entire length of the chain is about 840 geographical miles, lying between Lat. 38. and 44. N. and Long. 7. 40. and 18. 20. E. They are divided into the Northern, Central, and Southern Apennines.

The *Northern Apennines* are separated from the Maritime Alps by the Tanaro and the Roya, which have their sources in Monte Cassino, and extend to Monte Coronaro. This division comprehends three subdivisions. The first, extending to Monte Bocchetta, proceeds first in an easterly direction, and afterwards, turning to the north-east, runs almost parallel to the western coast of the Gulf of Genoa, which it approaches so closely as to leave little more than a mere passage. The principal passes here, between Piedmont and the duchy of Genoa, are through the valleys of the Tanaro, the Bormida, and the Lemme. From Bocchetta the second subdivision extends in an eastern, and afterwards in a south-eastern direction to the mountain summit, under which the Reno rises. Its highest summits are the Lopotorlo, Gottro, and Jorame, in which rise the Trebbia, Taro, and Secchia, affluents of the Po. The chief passes are those of Boffaloro Cento-Croci, Pontremoli, Bratello, Fiumalbo, and Monte Carelli or Pietra-Mala. This subdivision forms the spacious bays of Rapallo and Spezzia, and its deep ravines and precipitous sides are characteristics which distinguish it from the rest of the chain. The third subdivision extends in a south-south-east direction to Monte Coronaro. The principal summits here are the Piano and the Falterona. The only pass worthy of notice is that proceeding from the valley of the Lieve, over Borgo di San Lorenzo, through the valley of the Lamore, and on towards Faenza.

The *Central Apennines* comprehend that part of the chain between Monte Coronaro, in which the Tiber rises, and Monte Velino, north of Lake Fucino. Its general direction is from north-north-west to south-south-east, and nearly parallel to the Tiber. The descent towards the Adriatic is continuous and direct, but towards the Mediterranean it forms two distinct inclined planes. The principal passes from the north are at the village of Scheggia, over a connecting ridge between Mounts Corno and Cucco, where the Cantiano, an affluent of the Metauro rises; at Seravalle, south-east of Monte Pennino, at the head of the valley of the Chienti, a small river flowing into the Adriatic; at Castellucio between Norcia and Arquate; and finally, the principal pass between Rieti and Aquila, to the east of Antrodoco.

The *Southern Apennines* include the remaining portion of this chain. From Monte Velino they proceed in a south-easterly direction to Acerenza in Basilicata, where they divide into two unequal branches, the eastern proceeding through the provinces of Bari and Otranto, and terminating at Cape Santa Maria di Leuca; the other, or western branch, running through Calabria to Cape dell' Armi on the Strait of Messina. In the upper part of the southern Apennines a number of sharp pyramidical points raise themselves above the mountain chain. Among these are Monte Forcone at the source of the Sangro, Monte Sant' Angelo, above the sources of the Volturno and Trigno, and Monte Calvello north-east of Salerno. The principal passes over this part of the Apennines are the pass of Sulmona, near the sources of the Volturno, so called from the town of Sulmona where the roads from Rome, Pescara, and Aquila

unite; the road going southwards by Pettorano, passing the upper Sangro, over Monte Janipro and the Iserina, and then dividing itself into two roads, the one southwards to Capua, the other eastwards by Campobasso towards Lucera and Foggia. The passes above Castel Franco and Ariano are the highest points of the road over the mountain ridge from Benevento to Troja, and from Avellino to Foggia. The eastern branch of the southern Apennines begins at the Lake of Pesole, and proceeds in an easterly, and afterwards in a southern direction to its termination at Cape Leuca. At Monte Albano it approaches very near the coast of the Adriatic. The best passages here are on the road from Taranto to Canosa, and from Ofanto and Bari to Ostani, Mesagna, and Lecca, which often contract into narrow defiles. The western branch extends in a southern direction from the Lake of Pesole to Capo dell' Armi. The principal passes here are in Calabria on the road from Naples to Sicily, and from Naples to Otranto passing by Taranto.

Connected with this main chain of the Apennines are three distinct groups of mountains, which usually take the distinguishing prefix of "Sub." These are the sub-Tuscan, the sub-Roman, and the sub-Vesuvian Apennines.

The *Sub-Tuscan Apennines* are a distinct group of mountains, extending over Tuscany. They are separated from the main range by the valleys of the Arno and Tiber, as well as by the Chiana, whence they diverge in the form of an obtuse angle towards the Mediterranean, covering with their ramifications all the country between the Arno and Po. On the top of the mountain range separating the Tiber from the Arno is the Lake of Perugia, which has no visible outlet. This range afterwards divides itself into several branches, between the two principal of which lies the district of the *Maremma* of Siena. The two principal passes here are those from Florence to Rome; the eastern going by Arezzo, thence above the Lake of Perugia to Foligno, &c.; the other from Siena over the two highest points of the two principal branches mentioned above, the one beyond Castiglioncello, the other on this side of Radicofani. From Siena there are also communications to Leghorn, Piombino, and Civita Vecchia.

The *Sub-Roman Apennines* detach themselves from the main chain near Monte Velino. They commence in the upper valleys of the Liri, Salto, Turano, and Sacco, where they contain the mountains of Cantaro, Corglio, Acuto, Carbonara, Ceraso, and Campatri, and afterwards lose themselves below the Lake of Albano. From the extremity a branch goes off almost in a straight line from Narni on the Nera to Sora on the Liri, and forms the valley of Velino. A second branch incloses the valley of the Anieno, the upper part of the Teverone, and divides the Liri from the Sacco. In the vicinity of Palestrina a third branch runs off between the Sacco and the Garegliano on the east, and the Pontine Marshes on the west, and terminates in a steep rocky tongue of land, on which the Fort of Gaeta stands. The extreme declivity forms the seven hills on which Rome is built. Over the main branch of this group there are three passes; the first, between the sources of the Liri and the Sacco, is the means of communication between Lora and Tagliacozzo, and hence it sends forth three branches to Aquila, Rieti, and Rome; the second extends from Zagarolo to Palestrina, on the direct route from Rome to Lora; the third passes above the lake, and is the great road from Rome to Naples by Terracina. Besides these there are other passes, as those from Rieti and Leonessa, the first proceeding to Viterbo and Rome, the other to Spoleto and Aquila; that from Celano to Carsoli on the road from Trivoli to Salmona; a by-way also goes from Carsoli in a north-western direction to Rieti through the valley of Turano.

The *Sub-Vesuvian Apennines* derive their name from the volcano Vesuvius which, with Somma, are the principal mountains of this group, and from which ramifications proceed in several directions. The only passage is that of Forchia or Claudina, near Monte Sarchio, north-east of Naples, and on the road to Benevento. See VESUVIUS.

The Apennines consist in part of white compact limestone containing no petrifactions or other heterogeneous substances. This rock does not, however, prevail through the whole range. From its junction with the Alps to Florence the chain is composed of calcareous or slaty masses, and of a serpentine rock called *gabbro* or *granitello*. This last principally composes the summits of the Mountains of Genoa rising from the Gulf of Spezzia. This part of the northern Apennines is generally considered to belong to the primitive formation, but some geologists contend that it belongs to the transition class with a large quantity of graywacke. The mountains extending from Florence to the Abruzzi and hence to Calabria, are composed of limestone analogous to that of the Jura range. In the last-mentioned province the central part of the chain is formed of granite, gneiss, and mica-schist, on which here and there repose some secondary deposits.

The Sub-Apennines belong to the tertiary formation, and are composed of marl, shale, gravel, sand, and conglomerate. Gypsum and calcareous and volcanic tufa are also seen here, but less frequently. Travertin, a limestone of recent formation, is found abundantly in the vicinity of Rome, and of it most of the edifices of that city are constructed. The volcanic mountains are all on the south-western side of the chain, with only one exception (Monte Voltore, near Melfi). The principal groups are those of Santa Fiora and Viterbo; that of Latium; those of Sant' Agatha and Rocca Monfina towards Sessa; and finally that of Naples. There is no active volcano except Vesuvius. Volcanic tufa forms a great part of the soil about Rome, and the Capitoline, Quirinal, Esquiline, Aventine, &c., are principally composed of it. Most of the lakes that surround Rome, as the Albano, Nemi, &c., occupy ancient craters. The environs of Modena abound in those small mud volcanoes called *Salzes*. They sometimes disengage carburetted hydrogen gas, and often this is inflamed, as may be seen at Villeia, Pietra Mala, and Barigazza. The Apennines contain few metals; the principal is iron, found in Tuscany, and particularly in the island of Elba. The coal mines are very unimportant, but there are extensive saliferous depôts near Cosenza. The marbles of the Apennines, however, are justly celebrated for their beauty, as those of Carrara, the ancient Luni, Seravazza, and Sienna.

APENRADE, a city in the duchy of Schleswig, the capital of the bailiwick of the same name. It contains 4200 inhabitants, chiefly occupied in agriculture, ship-building, and the transit trade. The harbour is shallow, and vessels must discharge below the town. The roadstead at the entrance is without shelter. Long. 9. 25. E. Lat. 55. 2. N.

APER, the wild boar. See *Sus Aper*, MAMMALIA.

APERIENT, a term applied to those medicines which act as deobstruents, and promote the secretions. See CATHARTICS.

APERTURE, in *Geometry*, the space between two right lines which meet in a point and form an angle.

APERTURE, in *Optics*, a round hole in a turned bit of wood or plate of tin, placed within the side of a telescope or microscope, near to the object glass, by means of which fewer rays are admitted, and a more distinct appearance of the object is obtained.

APETALOSE, or APETALOUS, among *Botanists*, an appellation given to such plants as have no flower-leaves.

APEX, the vertex or summit of any thing.

Apex, in *Antiquity*, the crest of a helmet, but more especially a kind of cap worn by the flamens.

Apex, among *Grammarians*, denotes the mark of a long syllable, falsely called a *long accent.*

APHÆRESIS (ἀπὸ and αἱρέω), a figure by which a letter or syllable is cut off from the beginning of a word. Thus *ciconia*, by aphæresis, is written *conia; contemnere, temnere; omittere, mittere,* &c.

APHEK, the name of several cities mentioned in Scripture. 1. A city in the tribe of Asher, supposed to be the same place with the Ἄφακα which Eusebius and Sozomen place in Lebanon, on the river Adonis, where there was a famous temple of Venus. A village called Afka is still found in Lebanon, situated at the bottom of a valley, and may possibly mark the site of this town. 2. A town near which Benhadad was defeated by the Israelites (1 Kings xx. 26, *sq.*); it seems to correspond to the Aphaca of Eusebius, situated to the east of the Sea of Galilee, and mentioned by Burckhardt, Seetzen, and others, under the name of Feik. 3. A city in the tribe of Issachar, not far from Jezreel, where the Philistines twice encamped before battles with the Israelites (1 Sam. iv. 1; xxix. 1). Either this or the first Aphek, but most probably this, was the *Aphek* mentioned in Josh. xii. 18, as a royal city of the Canaanites.

APHELIUM, or Aphelion (ἀπὸ from, and ἥλιος the sun), in *Astronomy*, is that point in any planet's orbit in which it is farthest distant from the sun, being that end of the greater axis of the elliptical orbit of the planet most remote from the focus where the sun is.

APHIOM, Karahissar. See Afium.

APHIS, the Puceron, Vine-fretter, or Plantlouse. See Entomology, *Index.*

APHLASTON, in Latin *Aplustre*, a wooden ornament, shaped like a plume of feathers, fastened on the goose's or swan's neck used by the ancient Greeks in the heads of their ships. The Aphlaston had much the same office and effect in a ship that the crest had on the helmet. It seems also to have had the further use of indicating the quarter of the wind by the waving of a party-coloured riband fastened to it.

APHLOGISTIC (α, priv., and φλόξ), or *Flameless Lamp.* This lamp is formed by winding a close coil of fine platinum wire loosely round the lower part of the wick of a spirit lamp. When the flame is extinguished, the coil will continue in a state of ignition till the spirit is consumed.

APHONIA (α, priv., and φωνή), a suppression or total loss of voice. It is never a primary disease, but a consequence of many different disorders. The cure is to be effected by removing the disorder from whence the aphonia proceeds.

APHORISM, a maxim or principle of a science, or a sentence which comprehends a great deal in a few words. The word comes from ἀφορίζω, *I separate.*

APHRACTI, in the *Ancient Military Art*, open vessels, without decks or hatches, furnished only at head and stern with cross planks, whereon the men stood to fight.

APHRODISIAS, the name given to several ancient cities in honour of Aphrodite.

APHRODITE, in *Grecian Mythology*, the goddess of love and beauty, one of the chief deities of Olympus. Homer calls her the daughter of Zeus, and the marine deity Dione. Hesiod derives her name from ἄφρος *foam*, as sprung from the foam of the sea. The Venus of the Romans had many of the attributes of Aphrodite; but there would seem to have been in the imagination of some of the ancients, a heavenly and an earthly Venus.

APHTHARTODOCETÆ, a name given to the followers of Julian of Halicarnassus, who taught, A.D. 519, that the body of Christ changed its nature and became incorruptible (ἄφθαρτος) from the moment of his conception, by the infusion of the divine nature. They were called also and Phantasiastæ, because their doctrine implied that the sufferings of Christ were not real but only seeming (δοκεῖν). This opinion was favoured by the Emperor Justinian, in whose reign it was agitated with great warmth.—(Mosheim, p. 237, Reid's edit.)

APHTHONG (from ἀπό φθόγγος), a letter or combination of letters, not sounded in the pronouncing of a word; as in a*l*mond, tong*ue*, apo*ph*the*g*m, *p*sa*l*m.

APHTHONIUS, *of Antioch*, lived about A.D. 315, and was the author of an elementary treatise on rhetoric (προγυμνάσματα), much read in the sixteenth and seventeenth centuries. He has also left about 40 Æsopic fables. The earliest edition of the *Progymnasmata* was contained in the *Aldine Rhetores Græci*, 1508. The best and latest edition, including all the annotations, is in the "Rhetores Græci" of Walz, Stuttg. and Tübing, 1832–35.

APHYLLOUS (α, priv., and φύλλον), in *Botany*, a term applied to plants which are leafless; such as the rush, mushroom, &c.

APIAN (properly *Bienewitz*), Peter, a distinguished astronomer, born in 1495, was professor of mathematics at Ingolstadt. His principal works are his *Cosmographia*, and his *Astronomicon Cæsareum;* the latter of which is remarkable as containing observations on the comet of 1531, subsequently known as *Halley's.* This work was illustrated with revolving paper planispheres. His son Philip was likewise a distinguished mathematician.

APIARY. Under the article Bee, in this work, directions will be given at considerable length as to the management of an apiary, and various methods detailed of procuring honey and wax from the hive without destroying the bees themselves. Greater attention to this useful appendage to the cottage would not only be productive of commercial advantage, but would tend to improve the condition of the lower order of peasantry. It is not generally known, indeed, what profitable returns may be obtained, at a trifling expense of time and labour, by very simple processes. Mr Huish, the author of a valuable practical treatise on the management of bees, has made a calculation, from which he infers, that even supposing the first cost of a swarm to be one guinea, which is the price in the places where they are sold the dearest, the cottager is almost certain, by proper care and management, of clearing, in five years, a net produce of nearly L.60, and of having besides, at the end of that period, ten good stocks of bees in his garden.

The principal objects to be attained in the construction and management of an apiary, are to secure the prosperity and multiplication of the colonies; to increase the amount of their productive labour; and to obtain their products with facility, and with the least possible detriment to the stock. The apiary should afford to the bees the best shelter against moisture and the extremes of heat and of cold, and especially against sudden vicissitudes of temperature; it should protect them against their numerous enemies; it should afford them every facility of constructing their combs, and of rearing their young; it should allow of every part of the combs being occasionally inspected, and being capable of removal when requisite; and, while due attention is paid to economy, it should be made of materials that will insure its durability. Much ingenuity has been displayed by different apiarians in the construction of hives which should unite in the greatest possible degree all these advantages. Although it be in vain to hope that every one of these objects can at once be perfectly attained, yet there is still great room for improvement on the hives that are at present in common use; and we shall here point out a few of the more recent modes of construction

Apiary.

While some cultivators of bees have been chiefly anxious to promote their multiplication, and to prevent the escape of the swarms in the natural way, by procuring what they have termed *artificial swarms*,—which they effected by separating a populous hive, previous to its swarming, into two parts, and allowing to each greater room for the extension of their works; others have contemplated only the abundance of the products which they yielded, and the facility of extracting them from the hive, without showing any particular solicitude as to the preservation of the bees themselves. Another class of apiarians have, on the other hand, had it more particularly in view to facilitate the prosecution of researches in the natural history and economy of bees. The hive invented by Mr Huber is peculiarly calculated for the last of these objects, and its construction is founded on an accurate knowledge of the habits of these insects. He has given it the name of *ruche en livre ou en feuillets*, from its opening and shutting somewhat in the manner of the leaves of a book. This *book* or *leaf hive* is composed of from eight to twelve square wooden frames, placed vertically, and joined together sidewise like the hoops of a cask. Each frame consists of two uprights, one inch in thickness, a foot in height, and an inch and a third in width, connected by an upper and lower cross bar, ten inches long, and of the same breadth and thickness as the former; so that all the frames may be joined together, without leaving any interval. The two external frames are closed each by a pane of glass, which is covered by a shutter on the outside; and the whole is properly secured in its place, and further protected by an external cover. An aperture must of course be left in the lower part of one of the frames to serve as a door. In order to determine the bees to construct their combs in the plane of each leaf, a small piece of honeycomb is fixed, by means of pegs, to the top of each in the proper position, as it is well known that bees always complete their work in the direction in which they find it begun, unless they meet with some insurmountable obstacle. A proper distance is thus preserved between the lateral surfaces of the perpendicular combs; and the external ones, being only three or four lines distant from the glass panes, may be easily inspected by opening the shutters; and also by opening in succession the different divisions of the hive, both surfaces of every comb may at pleasure be fully brought into view. No difficulty is experienced in introducing swarms into hives of this construction; and after the lapse of a few days, when the colony is fully established, the bees will very patiently submit to be daily inspected.

Mr Huber's hive.

Mr Huber's hive is exceedingly well calculated for producing artificial swarms on the principle of Schirach's discovery, of which a full account will be given in the article Bee. It allows us to judge by inspection whether the population is sufficient to admit of division,—if the brood is of the proper age,—and if males exist, or are ready to be produced, for impregnating the young queen; all which circumstances are of material consequence to the success of the operation. It is essential that some of the larvæ should not have been hatched above three days before this attempt is made. The frames must then be gently separated at the middle of the hive, and two empty frames be introduced in the interval between the former; each of these new frames having a partition which closes them completely, so as to enable the two portions to be entirely separated without leaving any opening. The door of that portion in which the queen happens to be at this time may remain open, but the one belonging to the other part must be closed, so as to retain the bees that have no queen prisoners for 24 hours, allowing still, however, sufficient circulation of air. After this interval of time they appear to have forgotten their queen, at least they are no longer anxious to seek for her, but bestow all their solicitude in the education of the larvæ, so as to convert a certain number of them into queens to supply the loss they have sustained. This they accomplish in ten days or a fortnight after the operation. The two colonies are now perfectly distinct, and are never found afterwards to intermix.

Another advantage attending a hive of this construction consists in its enabling us to force the bees to produce a much greater quantity of wax than they would naturally do. The interval which separates the combs when the bees have not been disturbed in their operations is constantly the same, namely, about four lines. Were they too distant, it is evident that the bees would be much dispersed, and unable to communicate their heat reciprocally, and the brood would not be preserved in a sufficient degree of warmth. Were the combs too close, on the contrary, the bees could not freely traverse the intervals, and the work of the hive would suffer. It is evident that we may avail ourselves of this instinct, and, by separating farther asunder the combs that are already built, induce the bees either to extend the breadth of those they had begun, or to build others in the interval, if sufficient space be allowed them for this purpose. Thus, by interposing three empty frames, one between every alternate interval of the combs in a hive containing six combs, three additional combs, if the proper season be chosen, will be obtained at the end of a week; and if the weather continue favourable, the operation may be repeated, and the same number of additional combs procured the week after.

The principal obstacles to the general employment of Mr Huber's hives are the expense of constructing them, and the greater degree of attention which they perhaps require from the cultivator. It has also been objected that the flatness of the roof was prejudicial, by allowing the moisture which exhales from the bees to collect at the top, and to fall in drops at different parts, to the great injury of the subjacent contents of the hive. Feburier proposes therefore the employment of frames in the form of a trapezium, so that the roof shall be considerably inclined to the horizon. He borrows this shape from Bosc, whose hive consists, however, only of two boxes joined together sidewise, and separable in order to form artificial swarms. This was an improvement upon Gelieu's hive, which was formed of two square boxes united laterally. Delator had recommended a still more simple form than that of Bosc, though less convenient; namely, that of a triangle resting on its base. Mr Ravenel's hive consists of three square boxes instead of two; Mr Scrain's is also made up of three boxes, but they are low and of great length, and are joined endwise,—a communication being established between them by apertures made in the divisions which separate the boxes. It is now, however, well established, that partitions of any kind are detrimental to the prosperity of the colony. The same objection applies, though perhaps in an inferior degree, to the system of storied hives, or those which are divided into stories one above another. A great variety of the latter description, however, have been recommended by different cultivators. In France they are known by the name of *ruches en hausses*. Mr Thorley's improved hive is of this class, and Mr Lombard's *ruche villageoise* may also be referred to the same head, although it be of much simpler construction than any other compound hive. Mr Lombard's hive is composed of two parts, a body and a cover, forming together an elevation of from seventeen to twenty inches, on a uniform diameter of one foot, excepting the upper part, which ought to be convex. The body is formed of bands of straw, similar to that of the cottages in this country,

Hives of other apiarians.

At the top and bottom of the body is placed an exterior band, which forms a projecting border on each end, the lower one giving the hive a firm station on its pedestal, the upper one contributing to secure the attachment of the cover, or allowing of another similar body being placed above the first, if such an addition should be deemed necessary. At the top of the body, and even with the upper band, is placed a flooring board, made of a light plank, ten inches in breadth in all directions, and the four corners of which are sawed off in such a manner that the breadth along the diagonal measures one foot. This board is fixed by nails inserted in the upper double band, and entering a little into the front. The four openings that are left on the sides are necessary for the passage of the bees, and for the escape of the vapours which are exhaled from them in winter. A flat rod traverses the hive immediately under the board, and projecting from the two sides about an inch and a half, affords handles for lifting the hive, and facilitates the fastening of the cover, which has also a projecting rod corresponding with that of the hive. At the bottom is an opening two inches broad and nine lines in height for the ingress and egress of the bees. The cover is formed in the shape of a dome, with a vertical handle at the top, and a cross bar at the lower part, by the projecting ends of which it may be tied to the ends of the bar in the body, and which serves also as a support to the combs that are constructed in the cover. For the latter purpose, also, two other bars are placed crosswise, one above the other. All the hives and all the bases of the covers are to be made of one uniform diameter, in order that the hives may, if occasion require it, be placed upon each other, and the covers be adapted to any of the hives that may happen to be at the top.

The *pyramidal hive* of M. Ducouédie, which the inventor extols in his book entitled *La Ruche Pyramidale, avec l'art d'établir et d'utiliser les ruches*, &c. as leaving nothing more to be wished for as to the cultivation of bees, differs but little from that of Mr Thorley. A common straw hive is taken, containing a swarm, which is allowed to remain till the spring of the following year; it is then placed on the top of a square box, with which it is made to communicate by a round aperture at the top of the box. In this state it is termed by the French *la ruche Ecossaise*, or, *ruche de M. de la Bourdonnaye.* In the following spring a second box is placed under the first, and the whole now assumes the name of *la ruche pyramidale.* The bees are still allowed no other ingress or egress but by a single hole made in the lowest story. The upper stories may then be removed in succession, while further room is allowed below by the addition of fresh boxes. It is stated by M. Ducouédie, that the bees in his pyramidal hive never perish by hunger or by cold; for they always abound in provisions, and are too numerous to be affected by the most rigorous winter. When the bees are in groups, they maintain the necessary warmth in the hive, and the brood, on the return of spring, is hatched one month sooner than in any other hive. Mr Huish has, however, made it clearly appear that these pretended advantages are much exaggerated, while its inconveniences are passed over in silence. It is difficult, if not impossible, to proportion the hives in all cases to the magnitude of the swarms, or to the energy with which they labour. The honey being taken from the oldest cells, is deteriorated by an admixture of pollen, communicating to it a degree of bitterness, of which it is difficult to deprive it; and it is less abundant, in consequence of the diminished capacity of the cells, in which the coccoons of successive bees in their state of nympha have accumulated. From their being divided into different stories, the bees are obliged to live, as it were, in different families; while their own preservation and that of the brood requires them to live in the strictest union. The heat is also lessened by the division of the bees into different groups. The upper part of these hives being all necessarily flat (except the first or straw hive), occasions a serious inconvenience, by allowing moisture to collect and drop down into the middle of the hive, instead of trickling down the sides. The injury which this does to the combs, and to the bees themselves, who are constantly exposed to its influence, is, according to Mr Huish, the most common cause of the loss of the hives during the winter. The bees, he observes, always begin their work in the most elevated point of the hive, and seek for that purpose the central part of the roof. If the top be flat, and especially if it be as spacious as in the hives called pyramidal, the bees will not find this centre; they will work one year in one part, and the following year in another. This is without doubt one of the causes which oblige a proprietor to wait three or four years before any honey can be gathered from these hives.

The hive recommended by Mr Huish as affording sufficient facility for examining any of the combs, and performing on them any operation at pleasure, is very similar in form to that described as being used in Greece. The body of the hive is a straw basket in the shape of a flower-pot, that is, of a broader diameter above than below. Eight pieces of well-seasoned wood, about eight inches broad and half an inch thick, are laid parallel to one another, at equal distances, over the top of the basket, and fastened to an outer projecting band: they are then covered with network, over which is placed a circular board, or what is better, a convex cover of straw extending over the whole of the top of the hive. This network obliges the bees to fasten their combs to the transverse boards, by means of which each comb can easily be lifted up without interfering with any other part of the hive, or occasioning the loss of a single bee; and the whole of the interior of the hive is thus open to inspection, and we are enabled to trace the devastations of the moth, or to ascertain the presence of any other enemy.—See the article Bee. (P. M. R.)

APICIUS. There were at Rome three persons of that name, all celebrated as epicures. The second, M. Gabius Apicius, is the most famous of the three. He lived under Tiberius, and invented various sorts of cakes and sauces which bore his name. He squandered L.800,000 on his luxurious appetite; and finding his fortune reduced to little more than L.80,000, he grew alarmed at the prospect of starvation, and poisoned himself. His last draught, according to Seneca, was the most commendable he had ever swallowed. His name was long venerated by the votaries of the gastronomic art, as the highest of culinary authorities; and rival schools of cookery claimed their descent from the great Apicius. A treatise, *De Re Culinaria, sive de Obsoniis*, &c., by an unknown writer under the assumed name of Cælius Apicius has been frequently reprinted. The best edition is that of Lister, Lond., 1705, 8vo.

APINGADAM, or Appingadam, a town of Holland, in the province of Groningen, and capital of the circle of the same name. Pop. 3600.

APION, a famous grammarian and commentator upon the Homeric poems, born at Oasis in the land of Apis, though he called himself an Alexandrian. He flourished A.D. 30, and was conspicuous for his opposition to the Jews. Some fragments of his writings are extant, including the story of Androclus and the Lion, preserved in Aulus Gellius; and his treatise against the Jews, preserved with the works of Josephus, who wrote a reply to it.

APIS, a divinity worshipped by the ancient Egyptians at Memphis under the form of an ox, having certain exterior marks. The soul of Osiris was supposed to subsist in

the body of this animal. "A white spot," says Pliny, "resembling a crescent, on the right side, and a lump under the tongue, were the distinguishing marks of Apis." When a cow, therefore, which was thought to be struck with the rays of the moon, produced a calf, the sacred guides went to examine it, and if they found it conformable to this description, they announced to the people the birth of Apis.

"Immediately," says Ælian, "they built a temple to the new god, facing the rising sun, according to the precepts of Hermes, where they nourished him with milk for four months. At the expiration of this term, the priests repaired in pomp to his habitation, and saluted him by the name of Apis. They then placed him in a vessel magnificently decorated, covered with rich tapestry, and resplendent with gold, and conducted him to Nilopolis, singing hymns and burning perfumes. There they kept him for forty days. During this space of time women alone had permission to see him, and saluted him in a particular manner. After the inauguration of the god in this city, he was conveyed to Memphis with the same retinue, followed by an innumerable quantity of boats sumptuously decked out. There they completed the ceremonies of his inauguration, and he became sacred to all the world. Apis was superbly lodged, and the place where he lay was mystically called *the bed*."

There was a mysterious term fixed for his life. "Apis," says Pliny, "cannot live beyond a certain number of years. When he has attained that period they drown him in the fountain of the priests; for it is not permitted to let him prolong his life beyond the period prescribed for him by the sacred books." When this event happened he was embalmed, and privately let down into the subterraneous place destined for that purpose, after which the priests announced that he had disappeared; but when he died a natural death before this period arrived, they proclaimed his death, and solemnly conveyed his body to the temple of Serapis. Huet, bishop of Avranches, has endeavoured to prove that Apis was a symbolical image of the patriarch Joseph, and has supported his opinion with all his erudition. Mr Bryant apprehends that the name *Apis* was an Egyptian term for father; that it referred to the patriarch Noah; and that the crescent which was usually marked on the side of the animal was a representation of the ark.

APIUM, a genus of *Umbelliferæ*, of which the best known is *A. graveolens*, celery.

APO (*Greek* ἀπό), a prefix to many words, signifying *from*. It corresponds to the Latin *ab*, and the English *off*.

APOCALYPSE, Revelation, the name of one of the sacred books of the New Testament, containing revelations concerning several important doctrines of Christianity. The word is Greek, and derived from ἀποκαλύπτω, *I reveal* or *discover*.

This book, according to Irenæus, was written about the year 96 of Christ, in the island of Patmos, whither St John had been banished by the Emperor Domitian. But Sir Isaac Newton places the writing of it earlier, viz., in the time of Nero. Some attribute this book to the arch-heretic Cerinthus; but the ancients unanimously ascribed it to John, the son of Zebedee, and brother of James, whom the Greek fathers called the *Divine*, by way of eminence, to distinguish him from the other evangelists. This book has not at all times been esteemed canonical. There were many churches in Greece, as St Jerome informs us, which did not receive it; neither is it in the catalogue of canonical books prepared by the council of Laodicea, nor in that of St Cyril of Jerusalem: but Justin, Irenæus, Origen, Cyprian, Clemens of Alexandria, Tertullian, and all the fathers of the fourth, fifth, and the following centuries, quote the Revelation as a book then acknowledged to be canonical. The Alogians, Marcionites, Cerdonians, and Luther himself, rejected this book; but the Protestants have forsaken Luther in this particular; and Beza has strongly maintained, against his objections, that the Apocalypse is authentic and canonical.

There have been several other works published under the title of *Apocalypse*. Sozomen mentions a book used in the churches of Palestine, called the *Apocalypse* or *Revelation of St Peter*. He also mentions an Apocalypse of St Paul, which the Copts retain to this day. Eusebius also speaks of both these Apocalypses. St Epiphanius mentions an Apocalypse of Adam; Nicephorus, an Apocalypse of Esdras; Gratian and Cedrenus, an Apocalypse of Moses, another of St Thomas, and another of St Stephen; St Jerome, an Apocalypse of Elias. Porphyry, in his life of Plotinus, makes mention of the Apocalypse or Revelations of Zoroaster, Zostrian, Nicothæus, Allogenes, &c.

APOCOPE (ἀπό and κόπτω), among *Grammarians*, a figure which cuts off a letter or syllable from the end of a word; as *ingeni* for *ingenii*.

APOCRISARIUS (ἀπόκρισις an answer), in *Ecclesiastical History*, a sort of resident in an imperial city, in the name of a foreign church or bishop, whose office was to negotiate, as proctor at the emperor's court, in all ecclesiastical causes in which his principals might be concerned. The institution of the office seems to have taken place in the time of Constantine, or not long after, when, the emperors having become Christians, foreign churches had more occasion to promote their suits at court than formerly. We find it, however, established by law in the time of Justinian. In imitation of this officer, almost every monastery had its Apocrisarius, or resident in the imperial city. The title and quality of apocrisary became at length appropriated to the pope's agent, or *nuncio*, as he is now called, who resided at Constantinople to receive the pope's despatches and the emperor's answers.

APOCRUSTICS, in *Medicine*, the same as repellents.

APOCRYPHA (ἀπόκρυφα, sc. βιβλία, *hidden, secreted, mysterious*), a term in *Theology*, applied in various senses to denote certain books claiming a sacred character. It is first found in this use in Clemens Alexandrinus, *Stromata*, 13, c. 4, ἐκ τινὸς ἀποκρύφων.

In the early ages of the Christian Church this term was frequently used to denote books of an uncertain or anonymous author, or of one who had written under an assumed name. Its application, however, in this sense is far from being distinct, as, strictly speaking, it would include *canonical* books whose authors were unknown or uncertain, or even *pseudepigraphal*.

In the *Bibliothèque Sacrée*, by the Rev. Dominican Fathers Richard and Giraud (Paris, 1822), the term is defined to signify—1*st*, anonymous or pseudepigraphal books; 2*d*, those which are not publicly read, although they may be read with edification in private; 3*d*, those which do not pass for authentic and of divine authority, although they pass for being composed by a sacred author or an apostle, as the *Epistle of Barnabas;* and, 4*th*, dangerous books composed by ancient heretics to favour their opinions. They also apply the name "to books which, after having been contested, are put into the canon by consent of the churches, as Tobit," &c. And Jahn applies it in its most strict sense, and that which it has borne since the fourth century, to books which, from their inscription, or the author's name, or the subject, might easily be taken for inspired books, but are not so in reality. It has also been applied, by Jerome, to certain books not found in the Hebrew canon, but yet publicly read from time immemorial in the Christian church for edification, although not considered of authority in controversies of faith. These were also termed Ecclesiastical Books, and consisted of the Books of Tobit, Wisdom, Ecclesiasticus, Baruch, the first two Books of Maccabees, the last seven chapters (according to Cardinal Hugo's division) of the Book of Esther, and those (so called) parts of the

Book of Daniel which are not found in Hebrew, viz., the Song of the Children, the Speech of Azariah, the History of Susannah, and the Fable (as Jerome calls it) of Bel and the Dragon. These have been denominated, for distinction's sake, the deutero-canonical books, inasmuch as they were not in the original or Hebrew canon. In this sense they are called by some the Antilegomena of the Old Testament. "The uncanonical books," says Athanasius, or the author of the *Synopsis*, "are divided into *antilegomena* and *apocrypha*."

Among spurious and Apocryphal Books, as distinct from Antilegomena or Ecclesiastical, are doubtless to be considered the Third and Fourth Books of Esdras; the Book of Enoch; the Testament of the Twelve Patriarchs: the Assumption of Moses, &c. These books were all known to the ancient fathers; and, although incontestably spurious, are of considerable value from their antiquity, as throwing light upon the religious and theological opinions of the first centuries. The most curious are the Third and Fourth Books of Esdras, and the Book of Enoch, which has been but recently discovered, and has acquired peculiar interest from its containing the passage cited by the apostle Jude.

Most of the apocryphal Gospels and Acts noticed by the fathers, and condemned in the catalogue of Gelasius, are generally thought to have been the fictions of heretics in the second century, and have long since fallen into oblivion. Of those which remain, although some have been considered by learned men as genuine works of the apostolic age, the greater part are universally rejected as spurious, and as written in the second and third centuries. A few are, with great appearance of probability, assigned to Leucius Clarinus, supposed to be the same with Leontius and Seleucus, who was notorious for similar forgeries at the end of the third century. The authorship of the *Epistle of Barnabas* is still a matter of dispute; and there appear strong grounds for believing the charge made by Celsus against the early Christians, that they had interpolated or forged the ancient Sibylline Oracles.

But, whatever authority is to be ascribed to these documents, it cannot be denied that the early church evinced a high degree of discrimination in the difficult task of distinguishing the genuine from the spurious books. "It is not so easy a matter," says the learned Jeremiah Jones, "as is commonly imagined, rightly to settle the canon of the New Testament. For my own part, I declare, with many learned men, that in the whole compass of learning I know no question involved with more intricacies and perplexing difficulties than this." (*New and Full Method*, vol. i. p. 15.)

Testimony and tradition are the principal means of ascertaining whether a book be canonical or apocryphal. Inquiries of this kind, however, must of necessity be confined to the few. The mass of Christians, who have neither time nor other means of satisfying themselves, must confide, in questions of this kind, either in the judgment of the learned, or the testimony at least, if not the authority, of the church.

The following are the principal apocryphal (or spurious) books of the Old Testament, which have descended to our times. The greater number of them can scarcely be considered as properly belonging to the Apocrypha of the Old Testament, as they have been most probably written since the Christian era, and not before the second century:—Third and Fourth Esdras, the Book of Enoch, the apocryphal Book of Elias the Prophet, the Third, Fourth, and Fifth Books of Maccabees (received by the Greek Church), the Ascension of Isaiah, the Assumption of Moses.

Of the New Testament, the following are the extant spurious Gospels:—The History of Joseph the Carpenter, which has been preserved in the East in an Arabic translation. The Gospel of the Infancy; the Gospel of Thomas the Israelite; the Protevangelion of James; the Gospel of the Nativity of Mary; the Gospel of Nicodemus, or Acts of Pilate. Besides these, many are cited by the fathers which no longer exist.

Of spurious writings of the nature of Acts of Apostles the following are extant:—The Creed of the Apostles; the Recognitions of Clement, or the Travels of Peter; the Shepherd of Hermas; the Acts of Paul, or the Martyrdom of Thecla; Abdias' History of the Twelve Apostles; the Constitutions of the Apostles; the Canons of the Apostles; the Liturgies of the Apostles. Of spurious Epistles,—The Epistles of Barnabas, Clement, Ignatius, and Polycarp; the Epistle of Paul to the Laodiceans; the Third Epistle of Paul to the Corinthians; the Epistle of Peter to James; the Epistles of Paul and Seneca.

Besides these many other pretended sacred writings were palmed upon the world, of which the titles alone are preserved, and probably many more of which the very names have perished. See Fabricii *Codex Pseudepigraphus V. T.*, 1713 and 1741, and *Codex Apocryphus N. T.*, 1713–1722; *Auctarium Codicis Apocryphi N. T. Fabriciani*, edidit And. Birch, 1804. *A New and Full Method of Settling the Canon of the N. T.*, by the Rev. Jeremiah Jones, 1827. Du Pin, *Prolegomena*, 1701, and *Canon of the Old and New Testaments*, 1700; and *Codex Apocryphus N. T.*, *opera et studio* T.C. Thilo, tom. i., Lips. 1832, 8vo.

APOCYNEÆ, a natural order of dicotyledonous plants. It includes many deadly poisons, as *Strychnos nux vomica*, *S. toxicaria*, *cerbora*, *&c.*

APODECTÆ (ἀποδέκται), in *Antiquity*, a denomination given to ten general receivers appointed by the Athenians, to receive the public revenues, taxes, debts, and the like. The apodectæ had also a power to decide all controversies arising in relation to money and taxes, except those of the most difficult nature and highest concern, which were reserved to the courts of judicature.

APODICTIC (ἀπόδειξις, a demonstration), a philosophical term originating with Aristotle, and introduced into modern usage by Kant, who applies it to those judgments that are beyond all contradiction, as distinguished from such as are merely empirical.

APODYTERIA (from ἀποδύομαι), in the ancient baths, the apartments for dressing and undressing.

APOGEE (ἀπὸ and γῆ), in *Astronomy*, that point in the orbit of a planet which is at the greatest distance from the earth. The apogee of the sun is that part of the earth's orbit which is at the greatest distance from the sun; and, consequently, the sun's apogee and the earth's aphelion are one and the same point.

APOKERUXIS (ἀποκήρυξις), was a legal process at Athens, by which a father could cast off and disinherit his son for deficiency in filial duty, riotous living, and the like, with power to reinstate him at pleasure.

APOLLINARIAN GAMES (*Ludi Apollinares*), in *Roman Antiquity*, were instituted in the year B.C. 212, after the fatal battle at Cannæ. The occasion was a kind of oracle delivered by the ancient prophet Marcius, declaring that, to expel the enemy, and cure the people of an infectious disease which then prevailed, sacred games were to be annually performed in honour of Apollo; the prætor to have the direction of them, and the decemviri to offer sacrifices after the Grecian rite. For some time they were moveable or indictive, but at length were fixed, under P. Licinius Varus, to the 6th of July, and made perpetual. The Apollinarian games were merely scenical, and at first only observed with singing, piping, and other sorts of music; but afterwards there were also introduced all manner of mountebank tricks, dances, and the like; yet they still remained scenical, no chariot races, wrestling, or laborious exercises of the body, being ever practised at them.

APOLLINARIANS, APOLLINARISTS, called also by

Epiphanius, *Dimæritæ*, ancient heretics who denied the proper humanity of Christ, and maintained that the body which he assumed was endowed with a sensitive, and not a rational soul, but that the Divine nature supplied the place of the intellectual principle in man. This sect derived its name from Apollinaris, bishop of Laodicea in the fourth century.

APOLLINARIS, SULPICIUS, a very learned grammarian, born at Carthage, lived in the second century under the Antonines. He is supposed to be the author of the verses which are prefixed to the comedies of Terence, and which contain the arguments of them. He had for his pupil Helvius Pertinax, who afterwards became emperor.

APOLLINARIS SIDONIUS, *Caius Sollius*, an eminent Christian writer and bishop in the fifth century, was born of a noble family in France. He was educated under the best masters, and made great progress in the several arts and sciences, but particularly in poetry and polite literature. He married Papianilla, the daughter of Avitus, who was consul, and afterwards emperor, by whom he had three children. But Majorianus, in the year 457, having deprived Avitus of the empire, and taken the city of Lyons, in which our author resided, Apollinaris fell into the hands of the enemy. The reputation of his learning softened Majorianus's resentment, so that he treated him with the utmost civility; in return for which Apollinaris composed a panegyric in his honour, which was so highly applauded, that he had a statue erected to him at Rome, and was honoured with the title of *Count*. In the year 467 the Emperor Anthemius rewarded him for the panegyric which he had written in honour of him, by raising him to the post of governor of Rome, and afterwards to the dignity of a patrician and senator. But he soon quitted these secular employments for the service of the church. The bishopric of Clermont being vacant in 472 by the death of Eparchius, Apollinaris, who was then only a layman, was chosen to succeed him. Clermont being besieged by the Goths, he animated the people to the defence of that city, and would never consent to a surrender; so that when it was taken, about the year 480, he was obliged to retire. He was soon, however, restored by Evaric, king of the Goths, and continued to govern the church as before. He died on the 21st of August 482. He is esteemed one of the most acute and vigorous writers of his age, both in prose and verse. His chief works are his *Panegyrics* upon the Emperors Avitus, Majorianus, and Anthemius, and a collection of *Letters* and *Poems*. The best edition of these productions is that by Sirmond, published in 1614, and republished by Labbé in 1652, in 4to. There is a French translation of his *Letters*.

APOLLO, in *Mythology*, a pagan deity worshipped by the Greeks and Romans, who was originally the god of the sun, and as such, synonymous with Ἥλιος or *Sol*.

Apollo had a variety of other names, derived from his principal attributes, or the chief places where he was worshipped. He was called the *Healer* (*Akestor*), from his enlivening warmth and cheering influence; *Nomius*, or the shepherd, from his fertilizing the earth, and thence sustaining the animal creation; *Delius*, from his rendering all things manifest; *Pythius*, from his victory over Python; *Lycius*, *Phœbus*, and *Phaneta*, from his purity and splendour. As Apollo is almost always identified by the Greeks with the sun, it is no wonder that he should have been dignified with so many attributes. It was natural for the most glorious object in nature, whose influence is felt and seen by every animated part of creation, to be adored as the fountain of light, heat, and life. The power of healing diseases being chiefly given by the ancients to medicinal plants and vegetable productions, it was natural to exalt into a divinity the visible cause of their growth. Hence he was also styled the *God of Physic*; and that external heat which cheers and invigorates all nature, being transferred from the human body to the mind, gave rise to the idea of all mental effervescence coming from this god; hence likewise, poets, prophets, and musicians, are said to be *Numine afflati*, inspired by Apollo.

Vossius has taken great pains to prove this god to be only a metaphorical being, and that there never was any other Apollo than the sun. "He was styled the *Son of Jupiter*," says this author, "because that god was reckoned by the ancients the author of the world. His mother was called *Leto* or *Latona*, a name which signifies *hidden*, because, before the sun was created, all things were wrapped up in the obscurity of chaos. He is always represented as beardless and youthful, because the sun never grows old or decays; and what else can his bows and arrows imply but his piercing beams?" And he adds, that all the ceremonies which were performed to his honour had a manifest relation to the great source of light which he represented.

Of the four Apollos mentioned by Cicero, it appears that the last three were Greeks, and the first an Egyptian, who, according to Herodotus, was the son of Osiris and Isis, and called *Orus*. Pausanias is of the same opinion as Herodotus, and ranks Apollo among the Egyptian divinities. The testimony of Diodorus Siculus is still more express; for in speaking of Isis, after saying that she had invented the practice of physic, he adds, that she taught this art to her son Orus, named *Apollo*, who was the last of the gods that reigned in Egypt.

To the other perfections of this divinity the poets have added beauty, grace, and the art of captivating the ear and the heart, no less by the sweetness of his eloquence, than by the melodious sounds of his lyre. One of the chief functions of this divinity was that of revealing the future to man, whence he was the great oracular divinity among the ancients.

The defeat of the serpent Python formed a celebrated incident in the history of Apollo. The waters of Deucalion's deluge, says Ovid, which had overflowed the earth, left a slime, from whence sprung innumerable monsters; and among others the serpent Python, which made great havock in the country about Parnassus. Apollo, armed with his darts, put him to death; which, physically explained, implies that the heat of the sun having dissipated the noxious steams, these monsters soon disappeared.

This event gave rise to the institution of the Pythian games, so frequently mentioned in the Grecian history; and it was from the legend of Apollo's victory over the Python that the god himself acquired the name of *Pythius*, and his priestess that of *Pythia*. The city of Delphi, where the famous oracles were so long delivered, was frequently styled *Pytho*.

APOLLO BELVEDERE, a representation of Apollo, generally ranked as the masterpiece of ancient statuary. It was so called from having been placed in the Belvedere of the Vatican by Pope Julius II., where it remained till 1797, when Rome was taken and plundered by the French. It was again restored after the peace of 1815.

This celebrated statue was found in the ruins of ancient Antium, now *Capo d'Anzo*, about the end of the fifteenth century. The artist and the epoch of its execution are unknown. It has been supposed to agree with the description of Pliny, *Hist. Nat.* xxxvi. 4, 10, and has been attributed by some to Calamis, by others to Phyliscus, and by others again to Praxiteles. The first was the opinion of Visconti (see Feuerbach's learned work, *Der Vaticanische Apollo*, Nuremb. 1833, 8vo). But according to the most probable opinion, this statue is sculptured in the Italian marble of Luni, and was executed about the time of Nero. See Tiersch, *Epochen*, &c. The hands and right arm which were wanting in the original, were restored by Angelo da Montorsoli, a pupil of Michael Angelo.

This wonderful work of art represents the highest ideal of manly beauty. "The lord of the unerring bow" has just discharged his arrow at the serpent Python. His cloak, his sole covering, lightly fastened round his neck, is flung over his left shoulder, and hangs gracefully from his outstretched arm, which grasps the still quivering bow. His face expresses the calm and proud triumph of a god, who needs but the putting forth of his hand to ensure him victory. "As the skilful artist," says Winckelmann, "wished to personify the most beautiful of the gods, he expressed only the anger in the nose—this organ, according to the old poets, being its appropriate seat—and the contempt on the lips. The latter emotion is manifested by the elevation of the lower lip, by which the chin is raised at the same time; the former is visible in the dilated nostrils." (*Hist. of Anc. Art among the Greeks*, p. 159, English translation. Lond. 1850.) The open right hand rests on the stump of a tree, around which winds a serpent, at once emblematic of the healing power of the god, and suggestive of the object of his victory.

APOLLODORUS, a celebrated painter of Athens about 408 years before the birth of Christ, was the first who invented the art of mingling colours, and of expressing lights and shades, on which latter account he received the name of Σκιαγράφος. He was admired also for his judicious choice of subjects, and for beauty and strength of colouring surpassed all the masters that went before him.

There was also a sculptor of this name who flourished about the same period, and made statues in bronze. He was surnamed the *Mad*, from his practice of breaking his works in pieces when they did not realize his idea.

Apollodorus *of Carystus*, a Greek comic poet, about 300 years B.C., was a native of Eubœa. He wrote, according to Suidas, 47 comedies, and gained the prize five times. His plays were composed at Alexandria, where they were greatly in esteem. The *Hecyra* and *Phormio* of Terence are said to have been imitated from this writer.—Meineke, *Hist. Crit. Comic. Græc.*

Apollodorus, tyrant of Cassandria, subverted the liberty of his country, B.C. 279, after having deceived the people by an appearance of ardent attachment to their rights. He was dethroned and put to death by Antigonus Gonatas.

Apollodorus *of Gela*, a Sicilian comic poet, said to have been a contemporary of Menander, and frequently confounded with Apollodorus of Carystus. Some fragments of his plays are given in Meineke's *History*.

Apollodorus *the Athenian*, a famous grammarian, the son of Asclepiades and disciple of Aristarchus. He wrote many works not now extant; but his most famous production is his *Bibliotheca*, which treats of the gods and the heroic ages. It is supposed by some that this is only an abridgment by another hand, and not the original work of Apollodorus. In any view it is, however, of great value in mythological inquiries. The best edition is that of Heyne, in 4 vols. 8vo, published in 1803. A French translation, with notes, was published at Paris in 1805, in 2 vols. 8vo.

Apollodorus *of Pergamus*, a Greek rhetorician, who founded a school called after his name. He taught at Rome and at Apollonia, and had Octavianus, afterwards Augustus, as his pupil.

Apollodorus, an epigrammatic poet, supposed to have been a native of Smyrna. He lived under Augustus and Tiberius. Thirty of his epigrams are preserved in the Greek Anthology.

Apollodorus, a famous architect under Trajan and Hadrian, was born at Damascus. Among his principal works were the Forum of Trajan, the Odeum, and various other public buildings at Rome; the triumphal arches at Beneventum and Ancona; and the great bridge of stone which Trajan ordered to be built over the Danube in the year 104, which was esteemed the most magnificent of all the works of that emperor. One day as Trajan was discoursing with this architect upon the buildings he had raised at Rome, Hadrian ventured to give his judgment, and showed he understood nothing of the matter. Apollodorus turned upon him bluntly, and said to him, "Go, paint gourds, for you are very ignorant of the subject we are talking upon." Hadrian at this time boasted of his painting gourds well. On Hadrian's elevation to the throne, Apollodorus was banished. He composed in his exile a treatise on Warlike Engines (πολιορκητικά), in a preface to which he supplicated the indulgence of the emperor. Hadrian sent him soon after the plan of a temple of Venus, which he had himself designed. Apollodorus criticized its dimensions, and remarked, "that if the goddess wished to rise and go out of the temple, she could not find room." This, with the former freedom of Apollodorus, so offended Hadrian, that he put the artist to death, on the pretext of imaginary crimes.—(Dion Cassius, lxix.)

APOLLONIA, an ancient city of Illyricum, near the mouth of the Avus, distinguished as a seat of learning towards the end of the Roman republic. This name was also borne by many other places.

Apollonia, a propitiatory festival solemnized at Sicyon in honour of Apollo and Artemis (Diana), to avert a pestilence. *Paus.* ii. 7. § 7.

APOLLONICON. See Organ.

APOLLONIUS *of Alabanda*, surnamed Molo, a distinguished Greek rhetorician, the instructor of Cæsar and of Cicero. He settled at Rhodes, and in the dictatorship of Sulla, was sent as ambassador from the Rhodians to Rome. He was the first Greek who addressed the senate without the aid of an interpreter. Cicero renewed his studies under him when he afterwards visited Rhodes on his return from Asia. The works of Apollonius have perished.

Another rhetorician of the same name, likewise a native of Alabanda, and an inhabitant of Rhodes, was surnamed the *Effeminate* (ὁ Μαλακὸς). Both are mentioned by Cicero with high respect.—Cicero, *Brutus*, 89, 90, 91; *De Inv.* i. 56; *De Orat.* i. 17, 28; Quintil. iii. 1. § 16; xii. 6, § 7, &c.

Apollonius, surnamed *Dyscolus* (Δύσκολος), or the *Crabbed*, was a native of Alexandria, and lived in the reigns of Hadrian and Antoninus Pius. Priscian calls him "*grammaticorum princeps*." He was the first systematic writer on grammar, and his extant treatises on various branches of the science, display great ingenuity and vigour of thought. These are, 1. On Syntax; 2. On the Pronoun; 3. On Conjunctions; 4. On Adverbs. The best edition of the Syntax is that of Bekker, Berlin, 1817.

Apollonius *of Perga*, in Pamphylia, is one of the most illustrious of the ancient Greek geometricians. The date of his birth has not been precisely ascertained; but as he flourished under Ptolemy Philopater, who died in the year 205 B.C., after a reign of 16 years, it is conjectured that he was born about the middle of the third century before our era, and that he was about 40 years posterior to Archimedes. He studied at Alexandria under the successors of Euclid, and is pre-eminently distinguished among the disciples of that illustrious school, in which the mathematical sciences were at all times held in the highest estimation.

Few of the numerous compositions of Apollonius have escaped the ravages of time; but the description which has been given of them by Pappus, in the preface to the seventh book of the *Mathematical Collections*, explains their nature and value, and gives the admirers of the ancient analysis great reason to regret the loss of those which have perished. The most celebrated of his productions was the treatise on the *Conic Sections;* a work which, according to the testimony of Geminius Rhodius, was regarded with so much admiration by the contemporaries of

its author, that they bestowed on him the title of the *Great Geometrician*. This title is justified by the excellence of the work, which is unquestionably far superior to any treatise on the subject which we know to have existed among the ancients, and which has not indeed, in some respects, been surpassed in modern times. But while we bestow this praise on the treatise of Apollonius, we are not to suppose that he was the inventor of all, or even the greater part, of the properties which are demonstrated in it. Several treatises on the conic sections are known to have existed previously, in which the theory of these curves seems to have been prosecuted to a very considerable length. Pappus mentions, in particular, in terms of the highest eulogy, the five books on Solid Loci, or the conic sections, which were composed by Aristæus *the ancient*, who lived about 350 years B. C.; and the construction given by Menechmus, of the problem to find two mean proportionals between two given straight lines, which leads to the duplication of the cube, shows that the disciples of Plato had advanced far in the same department of geometry. In fact, as it was the object of Apollonius to give a complete treatise of the conic sections, he did not scruple to avail himself of the discoveries of his predecessors, and, accordingly, embodied in his own work what had previously been done by Aristæus, Eudoxus of Cnidus, Menechmus, Euclid, Conon, Thrasidæus, Nicoteles, and others. It is now impossible to distinguish the propositions which were borrowed from his predecessors from those which were invented by himself; but it is certain that he both made great additions to the theory of the conic sections, and improvements in the manner of treating it. Eutocius informs us that Apollonius was the first who showed that all the three sections may be cut from the same cone, by varying the position of the intersecting plane; for previous authors had always supposed the plane of the section perpendicular to the side of the cone,—an hypothesis which requires that the three sections be cut from three cones of different species, namely, the parabola from a right-angled cone, the ellipse from an obtuse, and the hyperbola from an acute. It has, however, been established by Guido Ubaldus, in his commentary on the second book of the *Æquiponderantes* of Archimedes, that the Syracusan geometer was acquainted with the fact, that the three sections may be derived from the same cone. The generalization is indeed so very obvious, that we can scarcely persuade ourselves that it was not previously made by the more ancient writers; and it is probable, that if they usually assumed the cutting plane to have a particular position with reference to the cone, it was only on account of some facilities which that hypothesis afforded them in establishing the fundamental properties of the sections. Pappus ascribes to Apollonius the names by which the three sections are now distinguished and characterized: the term *Parabola*, however, occurs in the writings of Archimedes.

Of the eight books which Apollonius composed on the conic sections, the first four only have reached us in the original Greek. Three more have been preserved through the medium of an Arabic version; the last is unfortunately lost. A Latin translation of the first four was published by Memmius, at Venice, in 1537; and another, much more accurate, by Commandine, in 1568, with the addition of the commentary of Eutocius, and the lemmas of Pappus to all the eight books. Hitherto the last four books had not been discovered; but as the nature of their contents was sufficiently known from the indications of Pappus, several attempts were made to supply their loss by a restoration. Maurolycus, a Sicilian geometer of the 16th century, successfully commenced the theory of the fifth and sixth books; and Viviani, the last and favourite disciple of the illustrious Galileo, was employed on the same subject, when two different manuscript versions of the work of Apollonius were accidentally brought to light. Among a number of Arabic manuscripts brought from the East by Golius, one was found which contained seven books of the conics. Golius was sufficiently instructed in geometry to be aware of the value of his discovery; he hastened to communicate it to the mathematicians of that time, and proposed to publish a translation of the work. This project, however, failed from some cause which has not been explained; and, notwithstanding the intimation which had been given, the last four books still continued to be regarded as lost, till the year 1658, when Alphonso Borelli, the celebrated author of the treatise *De Motu Animalium*, happened to discover, in the library of the Medici at Florence, an Arabic manuscript with the following inscription: *Apollonii Pergæi Conicorum Libri Octo*. Borelli obtained permission to carry this manuscript to Rome, where, with the assistance of Abraham Ecchellensis, he translated the fifth, sixth, and seventh books. Notwithstanding the inscription, the eighth book was wanting; and as this was also the case with regard to the manuscript of Golius, it seems probable that it had not been translated into Arabic.

The last four books of the conics of Apollonius formed a considerable part of what may be termed the transcendental geometry of the ancients; and they exhibit some of the most elegant and successful applications of the geometrical analysis. The fifth book, for example, which treats of the greatest and least lines that can be drawn from given points to the peripheries of the curves, contains nearly all the properties of normals and radii of curvature which are now generally investigated by the aid of the differential calculus, and almost anticipates the admirable theory of involutes and evolutes which confers so brilliant a lustre on the name of Huygens. The seventh book also contains some theorems which, although they have now passed into the elements, are sufficiently difficult and remote to afford scope for the exercise of address and ingenuity, even when their investigation is attempted by the modern analysis. Dr Halley, guided by the description of Pappus, divined the contents of the eighth book, and published a magnificent edition of the whole at Oxford in 1710.

The other treatises of Apollonius which are mentioned by Pappus are the following:—1*st*, The Section of Ratio, or Proportional Sections; 2*d*, the Section of Space; 3*d*, the Determinate Sections; 4*th*, the Tangencies; 5*th*, the Inclinations; 6*th*, the Plane Loci. Each of these was divided into two books, and, with the *data* of Euclid and the *porisms*, they formed the eight treatises which, according to Pappus, constituted the body of the ancient analysis. Of the above treatises of Apollonius, the first only has reached us through an Arabic translation. It was discovered in Arabic among the Selden manuscripts in the Bodleian Library at Oxford, by Dr Edward Bernard, who commenced a translation of it, from which, however, he was deterred by the difficulties occasioned by the extreme inaccuracy of the manuscript before he had finished a tenth part. This small portion of the translation was revised by Dr David Gregory; the rest was translated, or more properly speaking, divined, by Dr Halley, who published it in 1706, together with the analogous treatise on the *Section of Space*, which he had restored after the indication of its contents given by Pappus. The general problem resolved in the first treatise, although it is branched out into a great variety of cases, may be comprehended in the following enunciation: "Two straight lines being given by position, together with a point in each, it is required to draw through a third given point a straight

 line intersecting the two former straight lines, so that the segments intercepted between the given points and the points of intersection with the third line may be to each other in a given ratio." The problem which forms the subject of the second treatise differs from the above only in requiring that the intercepted segments on the two straight lines given by position shall contain a given rectangle.

The object of the treatise on the *Determinate Sections* was "to find a point in a straight line given by position, the rectangles or squares of whose distances from given points in the given straight line shall have a given ratio." A restoration of this and the two preceding treatises was attempted by Snellius; but although he certainly resolved the problems which had been proposed by Apollonius, his solutions were far inferior in point of elegance to those of the Greek geometer. The discovery of the treatise on the Section of Ratio enabled a comparison to be made of the restored with the original work. Some cases of the *Determinate Section* were also resolved by Alexander Anderson of Aberdeen, in his supplement to the *Apollonius Redivivus*, published at Paris in 1612. But by far the most complete and elegant restoration of the problem was given by Dr Simson of Glasgow, with two additional books on the same subject. It has been published among his posthumous works.

The treatise on *Inclinations*,—the object of which was to insert a straight line of a given length, and tending to a given point, between two lines (straight lines or circles) given by position,—was first investigated by Marinus Ghetaldus, a patrician of Ragusa, afterwards by Hugo de Omerique in his ingenious treatise on the *Geometrical Analysis*, published at Cadiz in 1698. The different cases of the problem have been resolved in a very elegant manner by Dr Horsley, who published his restoration in 1770.

The treatise *de Tactionibus*, which relates to the contact of circles and straight lines, has afforded exercise for the ingenuity of many modern mathematicians. The general problem which it embraces may be enunciated as follows: Three things (points, straight lines, or circles) being given by position, it is required to describe a circle which may pass through the given points and touch the given straight lines and circles. The most difficult case of the problem is that in which the three things given are circles; the question being then to determine the centre and radius of a circle, which shall touch these circles given in magnitude and position. This problem, which is now considered as quite elementary, possesses an historical interest on account of the great names connected with its solution. It was proposed by Vieta, the most skilful geometrician of the 16th century, to Adrianus Romanus, who, in constructing it, employed the very obvious consideration of the intersection of two hyperbolas. Such a solution of a plane problem, which ought to be constructed by means of straight lines and circles only, was very far from being satisfactory to Vieta: he therefore himself proposed a more geometrical construction, and restored the whole treatise of Apollonius, in a small work which he published at Paris in 1660 under the title of *Apollonius Gallus*. The treatise of Vieta is entitled to the praise of great ingenuity, but it falls far short of the geometrical elegance of the known productions of Apollonius; and simpler solutions have since been found of the more difficult cases of the general problem. An algebraic solution of the same question was attempted by Descartes; but the equations at which he arrived were so exceedingly complicated, that he himself ingenuously confessed that he should not be able to construct one of them in a shorter time than three months. The Princess Elizabeth of Bohemia, who carried on an epistolary correspondence with Descartes, gave a solution of the same kind. Newton himself, in his *Universal Arithmetic*, condescended to consider this problem; but he succeeded little better than Vieta, whose method he followed. In the 16th lemma of the first book of the *Principia*, he has, however, given a different and simpler investigation, and reduced with great skill the two hyperbolic loci of Adrianus Romanus to the intersection of two straight lines. Simple geometrical solutions, since that of Dr Simson was published, are to be found in every elementary work. In speaking of this problem, Montucla observes, that it is one of those to which the algebraic analysis applies with difficulty. His opinion, however, would have been different had he lived to see the extremely simple and elegant algebraic investigation given by Gergonne in the *Annales des Mathématiques*, not only of this, but of the analogous problem in space which was proposed by Descartes to Fermat, viz. to describe a sphere touching four spheres given by position. In fact, it would be difficult to select a problem in elementary geometry better calculated to display the resources and pliability of the algebraic calculus, than this very one which had been considered as belonging so exclusively to the analysis of the ancients. A very full and interesting historical account of this problem is given in the preface to a little work of Camerer, entitled *Apollonii Pergæi quæ supersunt, ac maxime Lemmata Pappi in hos libros, cum Observationibus*, &c. Gothæ, 1795, 8vo.

The last of the treatises mentioned by Pappus,—*de Locis Planis*,—is only a collection of properties of the straight line and circle, and corresponds to the construction of equations of the first and second degree. It has been restored in the true spirit of the ancient geometry by Dr Simson, whose treatise well deserves the attention of the student.

Besides the works which we have now enumerated, we are informed, by the fragment of the second book of Pappus, published among the works of Dr Wallis, that Apollonius occupied himself with arithmetical researches, and composed a treatise on the multiplication of large numbers. Astronomy is also indebted to him for the discovery, or at least for the demonstration, of the method of representing, by means of epicycles and deferents, the phenomena of the stations and retrogradations of the planets. He appears also to have been the inventor of the method of projections, and has the distinguished merit of having been the first who attempted to found astronomy on the principles of geometry, and establish an alliance between these two sciences which has been productive of the greatest benefit to both.

Of the personal character of this most assiduous and inventive geometrician, nothing is known excepting what may be gathered from a few unfavourable hints thrown out by Pappus. Pappus describes him as vain, arrogant, envious of the reputation of others, and inclined to depreciate their merit; and contrasts him with the amiable and disinterested Euclid, who was always ready to allow to every one his just share of praise, and who manifested on every occasion the most benevolent feelings towards all men, especially towards those who laboured to improve or extend the science of geometry. The charge of appropriating to himself the discoveries of Archimedes, which was brought against Apollonius by Heraclius, had probably no other foundation than the boastful manner in which he spoke of his own discoveries, and affected to despise those of other mathematicians; for, as has been well remarked, pretensions pushed too far excite in the rest of mankind a sort of re-action of self-love, which leads them to contest the most legitimate titles. But whatever may have been the case with regard to the per-

sonal qualities of Apollonius, the powers of his mind and his unwearied industry command universal admiration. The great value attached to his productions by the ancients is manifest from the number and celebrity of the commentators who undertook to explain them. Among these we find the names of Pappus, the learned and unfortunate Hypatia, Serenus, Eutocius, &c.

The remarkable editions of the works of Apollonius are the following:—1. *Apollonii Pergæi Conicorum libri quatuor, ex versione Frederici Commandini.* Bononiæ, 1566, fol. 2. *Apollonii Pergæi Conicorum libri* v. vi. vii. *Paraphraste Abalphato Asphanensi nunc primum editi: Additus in calce Archimedis Assumtorum liber, ex Codicibus Arabicis Manuscr.: Abrahamus Ecchellensis Latinos reddidit: J. Alfonsus Borellus curam in Geometricis Versioni contulit, et Notas uberiores in universum opus adjecit.* Florentiæ, 1661, fol. 3. *Apollonii Pergæi Conicorum libri octo, et Sereni Antissensis de Sectione Cylindri et Coni libri duo.* Oxoniæ, 1710, fol. (This is the splendid edition of Dr Halley.) 4. The edition of the first four books of the Conics given in 1675 by Barrow. 5. *Apollonii Pergæi de Sectione Rationis libri duo: Accedunt ejusdem de Sectione Spatii libri duo Restituti: Præmittitur,* &c. *Opera et Studio Edmundi Halley.* Oxoniæ, 1706, 4to.

See Bayle's *Dictionary;* Bossut, *Essai sur l'Hist. Gén. des Math.*, tome i.; Montucla, *Hist. des Math.*, tome i. Vossius *de Scient. Math.;* Simson's *Sectiones Conicæ*, preface; and Hutton's *Mathematical Dictionary.* (T. G.)

Apollonius, the author of the *Argonautics*, and surnamed the Rhodian, from the place of his residence, is supposed to have been a native of Alexandria, where he is said to have recited some portion of his poem while he was yet a youth. Finding it ill received by his countrymen, he retired to Rhodes, where he is conjectured to have polished and completed his work, supporting himself by the profession of rhetoric, and receiving from the Rhodians the freedom of their city. He at length returned with considerable honour to the place of his birth, succeeding Eratosthenes in the care of the Alexandrian library in the reign of Ptolemy Euergetes, who ascended the throne of Egypt in the year before Christ 246. That prince had been educated by the famous Aristarchus, and rivalled the preceding sovereigns of his liberal family in the munificent encouragement of learning. Apollonius was a disciple of the poet Callimachus; but their connection ended in the most violent enmity, which was probably owing to some degree of contempt expressed by Apollonius for the light compositions of his master. The learned have vainly endeavoured to discover the particulars of their quarrel. The only work of Apollonius which has descended to modern times is his poem above mentioned, in four books, on the Argonautic expedition. Both Longinus and Quintilian have assigned to this work the mortifying character of mediocrity. It was published for the first time at Florence in 1496, with the ancient Greek Scholia, in a 4to volume, now exceedingly rare. There is an excellent edition by Brunck, published in 1780, and another by Beck, published in 1797; but the best is that of Professor Schäfer, printed at Leipsic in 2 vols. 8vo, in 1810–13.

The *Argonautics* have been well translated into English verse by Fawkes and Green in 1780; another translation in English verse, with critical notes, was published by W. Preston in 1803.

Apollonius and Tauriscus of *Tralles*, the sculptors of the famous *Farnese Bull*, a group representing Zethus and Amphion tying the revengeful Dirce to the tail of a wild bull. This work is now at Naples. There were several other sculptors named Apollonius.

Another Apollonius, a sophist, wrote a Homeric Lexicon, which was first published by Villoison. His Λέξεις Ὁμηρικαί appeared in two vols. 4to, at Paris, in 1773.

Apollonius *of Tyana*, a celebrated Pythagorean philosopher, was born at Tyana, the capital of Cappadocia, a few years before the Christian era. At the age of 14 he was sent by his father to Tarsus, to study grammar and rhetoric under the Phœnician Euthydemus; but finding the vain and luxurious manners of that city unfavourable to serious study, he retired, with his father's permission, to the neighbouring town of Ægæ, where he spent most of his time in the temple of Æsculapius, in the company of priests and philosophers. Here he fell in with Euxenus, a philosopher who professed the principles of Pythagoras, but followed in his practice the less rigid maxims of Epicurus. Apollonius received with enthusiasm the Pythagorean instructions of Euxenus, and with more consistency than his master, determined at the age of 16 to mould his future life by the precepts of the Samian sage. Thenceforth renouncing the pleasures and luxuries of life, he devoted himself to the cultivation of his soul, and the improvement of his fellow-men. Abjuring the use of animal flesh and of wine, he fed on the simple fruits of the earth, wore no clothing but linen, and no sandals on his feet, suffered his hair to grow, and slept on the hard ground. The still more difficult penance of a five years' silence, prescribed by Pythagoras to his disciples, was a few years after strictly observed by Apollonius. This period he passed chiefly in Pamphylia and Cilicia, enduring the painful trial of passing through scenes of violence and disorder without suffering even a murmur to pass his lips; successful, however, if his admiring biographer may be credited, in restraining tumult and excess by the look of his countenance, or the silent eloquence of his hand. At the city of Aspendus, he found the inhabitants rising in mutiny against the governor, whom they unjustly blamed for the general scarcity of corn. The presence of Apollonius awed them into silence, and the governor urged in his own defence that the wealthy citizens who hoarded their corn were the authors of the famine. The excited populace were hurrying to take vengeance on the monopolizers, and plunder their stores, when Apollonius, by silent signs, hushed their fury, and the hoarders of the corn were brought into his presence. With difficulty restraining his voice, amid the tears of perishing women and children and old men, he wrote on a tablet the following words:—"Apollonius to the monopolizers of corn in Aspendus, greeting! The earth is the common mother of all, for she is just. You are unjust, for you have made her only the mother of yourselves: and if you will not cease from thus doing, I will not suffer you to remain upon her." This just rebuke, says Philostratus, had the desired effect: the market was filled with grain, and the city recovered from its distress. This story, whether true or not, may be taken as a fair indication of the real character of Apollonius, both as to the general tenor of his moral teaching, and his high and mysterious pretensions.

After spending some time at Antioch, Apollonius extended his travels into the East, and wandered over Assyria, Persia, and India, conversing with Magi, Brahmins, Gymnosophists, and priests, visiting the temples, preaching a purer morality and religion than he found, and attracting wherever he went admiration and reverence. At Nineveh he met with Damis, who became his disciple and the companion of his journeyings, and left those doubtful records of his life which Philostratus made use of, and probably improved upon. He afterwards visited Egypt, Greece, and Italy, and died, as is supposed, at Ephesus, at a very advanced age. His biographer has represented his death as involved in doubt and mystery, with the view of heightening the reverence due to his hero.

After his death Apollonius was worshipped with divine

honours for a period of four centuries. A temple was raised to him at Tyana, which obtained from the Romans the immunities of a sacred city. His statue was placed among those of the gods, and his name was invoked as a being possessed of superhuman powers. The defenders of Paganism, at the period of its decline, placed the life and miracles of Apollonius in rivalry to those of Christ; and some modern Deists have not disdained to make the same unworthy comparison.

The life of Apollonius by Philostratus, composed about 120 years after the philosopher's death, by order of Julia, wife of the Emperor Severus, is the only source of our information regarding him. Founded, as it is, on the insufficient testimony of Damis, combined with vague and exaggerated traditions, we are left to draw our estimate of Apollonius from mere probability. See Philostratus. It would seem, then, that though he may very possibly have been led, in his desire to strengthen his influence over men's minds, to use artifices and pretensions unworthy of a true sage, he was far from having been a vulgar or shallow impostor. With some of the spirit of a moral and religious reformer, he appears to have attempted, though vainly, to animate with a new and purer life the expiring breath of Paganism. His journey to the East was probably directed by the wish to trace the original traditions of the human race to their native source, believing, as he seems to have done, that these had been corrupted by the impure mythology of an artful priesthood. The story already quoted illustrates his doctrine that the earth was the common home of the human family, and that its inhabitants could attain true happiness only in the recognition of their mutual brotherhood. He inculcated the uselessness of supplication and of sacrifice, as unworthy of the Divine majesty, proclaiming the only acceptable offering to be a pure and devout heart.

In a philosophical relation, Apollonius may be regarded as the precursor of the Alexandrian philosophy, by bringing philosophy and religion into union, and attempting to combine the philosophical spirit of Greece with the mystical religion of the East. Of the authentic works of Apollonius none are extant but his *Apology*, preserved along with the life by Philostratus.

APOLLOS, in *Scripture History*, a Jew of Alexandria, who came to Ephesus during the absence of St Paul at Jerusalem (Acts xviii. 24). Apollos was an eloquent man, and well versed in the Scriptures, and preached in the synagogue, with zeal and fervour the doctrine of a Messiah, knowing as yet "only the baptism of John." Aquila and Priscilla having heard him, took him home with them, instructed him more fully in the doctrines of the Gospel, and baptized him.

Some time after this he travelled into Achaia; and, having come to Corinth, was there very useful in convincing the Jews out of the Scriptures, and demonstrating to them that Jesus was the Christ. Thus he watered what St Paul had planted in this city. (1 Cor. iii. 6.) But the great affection which his disciples entertained for him threatened to produced a schism, some saying, I am of Paul, others, I am of Apollos, I am of Cephas. This division, however, which St Paul speaks of in the chapter last quoted, did not prevent that apostle and Apollos from being closely united by the bonds of charity. Apollos hearing that the apostle was at Ephesus, went to meet him, and was there when St Paul wrote the first epistle to the Corinthians; wherein he testifies that he had earnestly entreated Apollos to return to Corinth, but hitherto had not been able to prevail with him; that nevertheless he gave him room to hope that he would go when he had an opportunity. St Jerome says that Apollos was so dissatisfied with these divisions at Corinth, that he retired into Crete with Zenas, a doctor of the law; and that this disturbance having been appeased by St Paul's letter to the Corinthians, Apollos returned to this city, and became its bishop. The Greeks made him bishop of Duras, others say he was bishop of Iconium in Phrygia, and others that he was bishop of Cæsarea.

APOLLYON, a Greek word that signifies *the destroyer*, and answers to the Hebrew *Abaddon*. See Abaddon.

APOLOGUE, in *Literature*, an ingenious method of conveying instruction by means of a feigned relation called a *moral fable*. The only difference between a parable and an apologue is, that the former, being drawn from what passes among mankind, requires probability in the narration; whereas the apologue, being taken from the supposed actions of brutes, or even of things inanimate, is not tied down to the strict rules of probability. The Æsopic fables are a model of this kind of writing.

APOMYOS (ἀπό, and μυῖα, *a fly*), in the *Heathen Mythology*, a name under which Zeus was worshipped at Elis, and Hercules as well as Zeus at the Olympic games. These deities were supplicated under this name to destroy or drive away the vast number of flies which always attended at the great sacrifices; and in those which accompanied the Olympic games, the first was always to the *Apomyos*, or *Myiagrus Theos*, that he might drive away the flies from the rest. The usual sacrifice was a bull.

APONO, Peter d', one of the most famous philosophers and physicians of his age, born in the year 1250, in a village about four miles from Padua. He was suspected of magic, and prosecuted by the Inquisition. "The common opinion of almost all authors," says Naudé, "is, that he was the greatest magician of his age; that he had acquired the knowledge of the seven liberal arts by means of the seven familiar spirits, which he kept inclosed in a crystal; and that he had the dexterity to make the money he had spent come back into his purse." The same author adds, that he died before the process against him was finished, being then in the 66th year of his age; and that, after his death, they ordered him to be burnt in effigy, in the public place of the city of Padua. He was the author of various works, the most remarkable of which are the following: *Conciliator Differentiarum Philosophorum*, first published in 1471; *De Venenis eorumque Remediis*, which was translated into French by Boet in 1593; *Expositio Problematum Aristotelis*, 1475; *Geomantia*, 1549; *Dionocides digestus Alphabet. Ord.* 1521.

APOPEMPTIC (ἀποπεμπτικά), in *Ancient Poetry*, a hymn addressed to a stranger on his departure from a place to his own country. The ancients had certain holydays wherein they took leave of the gods with *apopemptic* songs, as supposing them returning each to his own country. The deities having the patronage of divers places, it was but just to divide their presence, and allow some time to each. Hence it was that among the Delians and Milesians we find feasts of Apollo, and among the Argives feasts of Diana, called *Epidemiæ*, as supposing these deities then more peculiarly resident among them. On the last day of the feast they dismissed them, following them to the altars with *apopemptic* hymns.

APOPHORETA (ἀποφόρητα), in *Antiquity*, presents which the guests at an entertainment carried home with them. This was a common practice at all times, but especially at festivals, such as the Saturnalia.—See Martial. l. 14. Suet. *Vesp.* 19. *Cal.* 55. *Aug.* 75.

APOPHTHEGM (ἀπόφθεγμα), a short, sententious, and instructive remark.

APOPHYLLITE, a mineral belonging to the zeolite family. See Mineralogy.

APOPLEXY (ἀπόπληξις), a distemper in which the patient is suddenly deprived of all his senses, and of voluntary motion.

APORIA (ἀπόρια), a figure in *Rhetoric*, by which the speaker shows that he doubts where to begin for the multi-

tude of matter, or what to say in some strange and ambiguous thing, and, as it were, argues the case with himself.

APOSIOPESIS, in *Rhetoric*, afterwards called *reticency* and *suppression*, a figure by which a person really speaks of a thing, at the same time that he makes a show as if he would say nothing of it. The word comes from ἀποσιωπάω, *I am silent*. Example: "*I declare to you that his conduct —but we must not now lose time in words.*"

APOSPHRAGISMA (from ἀπό, and σφραγίζω, *I seal*), in *Antiquity*, the figure or impression of a seal.

APOSTASY (ἀπόστασις), a going away, or defection from one's original profession or party.

A POSTERIORI. See A PRIORI.

APOSTLE (ἀπόστολος), properly signifies a messenger or person sent by another upon some business; and hence, by way of eminence, denotes one of the disciples commissioned by Jesus Christ to preach the gospel.

Christ selected twelve out of the number of his disciples to be invested with the apostleship. Their names were Simon Peter, Andrew, James the Greater, John, Philip, Bartholomew, Thomas, Matthew, James the Less, Jude, surnamed Lebbeus or Thaddeus, Simon the Canaanite, and Judas Iscariot. Of these, Simon, Andrew, James the Greater, and John, were fishermen, and Matthew a publican, or receiver of the public revenue; of what profession the rest were we are not told in Scripture, though it is probable they were fishermen.

Our Lord's first commission to his apostles was in the third year of his public ministry, about eight months after their solemn election; at which time he sent them out by two and two. They were to make no provision of money for their subsistence in their journey, but to expect it from those to whom they preached They were to declare that the kingdom of heaven, or the Messiah, was at hand; and to confirm their doctrine by miracles. They were to avoid going either to the Gentiles or to the Samaritans, and to confine their preaching to the people of Israel. In obedience to their Master, the apostles went into all the parts of Palestine inhabited by the Jews, preaching the gospel and working miracles. The evangelical history is silent as to the particular circumstances attending this first preaching of the apostles, and only informs us that they returned and told their Master of all that they had done.

Their second commission, just before our Lord's ascension, was of a more extensive and particular nature. They were now not to confine their preaching to the Jews, but to "go and teach ALL nations, baptizing them in the name of the Father, and of the Son, and of the Holy Ghost." Accordingly, they began publicly, after our Lord's ascension, to exercise the office of their ministry, working miracles daily in proof of their mission, and making great numbers of converts to the Christian faith. This alarmed the Jewish Sanhedrim; whereupon the apostles were apprehended, and being examined before the high priest and elders, were commanded not to preach any more in the name of Christ. But this injunction did not terrify them from persisting in the duty of their calling; for they continued daily, in the temple, and in private houses, teaching, and preaching the gospel.

After the apostles had exercised their ministry for twelve years in Palestine, they resolved to disperse themselves in different parts of the world, and agreed to determine by lot what parts each should take. According to this division, St Peter went into Pontus, Galatia, and other provinces of the Lesser Asia; St Andrew had the vast northern countries of Scythia and Sogdiana allotted to his portion; St John's was partly the same with Peter's, namely, the Lesser Asia; St Philip had the Upper Asia assigned to him, with some parts of Scythia and Colchis; Arabia Felix fell to St Bartholomew's share; St Matthew preached in Chaldea, Persia, and Parthia; St Thomas preached likewise in Parthia, as also to the Hyrcanians, Bactrians, and Indians; St James the Less continued in Jerusalem, of which church he was bishop; St Simon had for his portion Egypt, Cyrene, Libya, and Mauritania; St Jude, Syria and Mesopotamia; and St Matthias, who was chosen in the room of the traitor Judas, Cappadocia and Colchis. Thus, by the dispersion of the apostles, Christianity was very early planted in a great many parts of the world. We have but very short and imperfect accounts of their travels and actions.

In order to qualify the apostles for the arduous task of converting the world to the Christian religion, they were, in the first place, miraculously enabled to speak the languages of the several nations to whom they were to preach; and, in the second place, were endowed with the power of working miracles, in confirmation of the doctrines they taught; gifts which were unnecessary, and therefore ceased, in the after ages of the church, when Christianity came to be established by the civil power.

St Paul is frequently called the *apostle* by way of eminence; and the *apostle of the Gentiles*, because his ministry was chiefly made use of for the conversion of the Gentile world, as that of St Peter was for the Jews, who is therefore styled the *apostle of the circumcision*. The several apostles are usually represented with their respective badges or attributes: Peter with the keys; St Paul with a sword; St Andrew with a cross or saltier; St James minor with a fuller's pole; St John with a cup, and a winged serpent flying from it; St Bartholomew with a knife; St Philip with a long staff, whose upper end is formed into a cross; St Thomas with a lance; St Matthew with a hatchet; St Matthias with a battle-axe; St James major with a pilgrim's staff and a gourd bottle; St Simon with a saw; and St Jude with a club.

APOSTLE was also used among the Jews for a kind of officer anciently sent into the several parts and provinces in their jurisdiction, by way of visitor or commissary, to see that the laws were duly observed, and to receive the monies collected for the reparation of the temple, and the tribute payable to the Romans.

APOSTLE, in the *Greek Liturgy*, is particularly used for a book containing the Epistles of St Paul, printed in the order in which they are to be read in churches through the course of the year. Another book of the like kind, containing the Gospels, is called Εὐαγγέλιον, *Gospel*. The Apostle, of late days, has also contained the other canonical epistles, the Acts of the Apostles, and the Revelation. Hence it is also called *Acts of the Apostles*, Πραξαπόστολος; that being the first book in it.

APOSTLE is also thought by many to have been the original name for bishops, before the denomination *bishop* was appropriated to their order. Thus Theodoret says expressly, the same persons were anciently called promiscuously both bishops and presbyters, while those who are now called bishops were called *apostles*.

APOSTLES' CREED, a formula or summary of the Christian faith, drawn up, according to Rufinus, by the apostles themselves, as a rule of faith, and as a *word of distinction*, by which they were to know friends from foes. Baronius and some other authors conjecture that they did not compose it till the second year of the reign of Claudius, a little before their dispersion. As to their manner of composing it, some fancy that each apostle pronounced his article, which is the reason of its being called *symbolum apostolicum;* it being made up of sentences jointly contributed, after the manner of persons paying each their club (*symbolum*) or share of a reckoning.

But there are reasons which may induce us to question whether the apostles composed any such creed as this. For, first, neither St Luke in the Acts, nor any other ecclesias-

tical writer before the fifth century makes any mention of an assembly of the apostles in order to the composing of a creed. Secondly, The fathers of the first three centuries, in disputing against the heretics, endeavoured to prove that the doctrine contained in this creed was the same which the apostles taught; but they never pretend that the apostles composed it. Thirdly, If the apostles had made this creed, it would have been the same in all churches and in all ages; and all authors would have cited it after the same manner. But the case is quite otherwise. In the second and third ages of the church there were as many creeds as authors, and one and the same author sets down the creed after a different manner in several places of his works, which is an evidence that there was not at that time any creed which was reputed the production of the apostles. In the fourth century Rufinus compares together the three ancient creeds of the churches of Aquileia, Rome, and the East, which differ very considerably in the terms. Besides, these creeds differed not only in the terms and expressions, but even in the articles, some of which were omitted in one or other of them, such as those of the *descent into hell*, the *communion of the saints*, and the *life everlasting*. From these reasons it may be gathered, that though this creed may be said to be that of the apostles in regard to the doctrines contained therein, yet it is not to be referred to them as the authors and first composers of it. Who was the true author of it, it is not easy to determine, though its great antiquity may be inferred from this, that the whole form, as it now stands in the English liturgy, is to be found in the works of St Ambrose and Rufinus, both of whom flourished in the fourth century.

APOSTOLEIS (ἀποστολεῖς), ten public officers at Athens who superintended the equipment and provisioning of the fleet by the trierarchs.

APOSTOLIANS, a sect of the Mennonites, which first sprung up in the year 1663, and derived its name from Apostool, one of the Mennonite ministers at Amsterdam. They concurred with them in doctrine, and admitted to their communion those only who professed to believe all the sentiments which are contained in their public confession of faith. See MENNONITES.

APOSTOLIC, in the *Primitive Church*, was an appellation given to all such churches as were founded by the apostles; and even to the bishops of those churches, as being the reputed successors of the apostles. These were confined to four, viz., Rome, Alexandria, Antioch, and Jerusalem. In after times other churches assumed the same quality, on account, principally, of the conformity of their doctrine with that of the churches which were apostolical by foundation, and because all bishops held themselves successors of the apostles, or acted in their dioceses with the authority of apostles.

APOSTOLICAL FATHERS is an appellation usually given to the writers of the first century who employed their pens in the cause of Christianity. Of these writers, Cotelerius, and after him Leclerc, have published a collection in two volumes, accompanied with their own annotations and the remarks of other learned men.

APOSTOLICI, or APOSTOLICS, was a name assumed by three different sects, on account of their pretending to imitate the manner and practice of the apostles. The first apostolici, otherwise called *Apotactitæ* and *Apotactici*, rose out of the Encratitæ and Cathari in the third century. They made profession of abstaining from marriage, and the use of wine, flesh, money, &c. Gerhard Sagarelli was the founder of the second sect; he obliged his followers to go from place to place as the apostles did, to wander about clothed in white, with long beards, dishevelled hair, and bare heads, accompanied by women, whom they called their spiritual sisters. They likewise renounced all kinds of property and possessions, inveighed against the growing corruption of the church of Rome, and predicted its overthrow, and the establishment of a purer church on its ruins. Sagarelli was burnt alive at Parma in the year 1300, and was afterwards succeeded by Dulcinus, who added to the character of an apostle that of a prophet and of a general, and carried on a bloody and dreadful war for the space of more than two years against Reynerius, bishop of Vercelli: he was at length defeated, and put to death in a barbarous manner, in the year 1307. Nevertheless, the sect subsisted in France, Germany, and other countries, till the beginning of the fifteenth century, when it was totally extirpated under the pontificate of Boniface IX. The other branch of apostolici was of the twelfth century. These also condemned marriage, preferring celibacy, and calling themselves the chaste brethren and sisters; though each was allowed a spiritual sister, with whom he lived in a domestic relation: and on this account they have been charged with concubinage. They held it unlawful to take an oath, they set aside the use of baptism, and in many things imitated the Manichees. Bernard wrote against this sect of apostolici.

APOSTOLICUM is a peculiar name given to a kind of song or hymn, anciently used in churches. The apostolicum is mentioned by Greg. Thaumaturgus as used in his time. Vossius understands it as spoken of the apostles' creed: Suicer thinks this impossible, because the creed was then unknown in the churches of the East.

APOSTROPHE (ἀποστροφή), in *Rhetoric*, a figure by which a person who is either absent or dead is addressed as if he were present and attentive to us. It also signifies a diversion from the main subject of a discourse; as when an advocate, in an argument to the jury, turns and addresses some incidental remark to the court.

APOSTROPHE, in *Grammar*, the contraction of a word by the use of a comma; as *call'd* for *called*, *tho'* for *though*.

APOTACTITÆ, or APOTACTICI. See APOSTOLICI.

APOTEICHISMUS, in the *Ancient Military Art*, a kind of line of circumvallation drawn round a place in order to besiege it. This was also called *periteichismus*. The first thing the ancients went about when they designed to lay close siege to a place, was the apoteichismus, which sometimes consisted of a double wall or rampart, raised of earth; the innermost to prevent sudden sallies from the town, the outermost to keep off foreign enemies from coming to the relief of the besieged. This answered to what are called *lines of contravallation* and *circumvallation* among the moderns.

APOTHECARY. In Scotland this term is restricted to one who compounds and sells drugs, and is used synonymously with the term Druggist or Pharmaceutical Chemist. These have never in Scotland enjoyed any status higher than that of ordinary shopkeepers. In England, again, the term means a general practitioner in medicine who also dispenses and sells drugs to his patients or the public; and the Apothecaries' Company of London is not only one of the city corporations, but also by an act of parliament licenses the general practitioners over England and Wales to deal in or sell drugs.

From early records we learn that the different branches of the medical profession were not regularly distinguished till the reign of Henry VIII., when they had separate duties assigned them, and peculiar privileges. In 1518 the physicians of London were incorporated; and the barber-surgeons in 1540. These two bodies as soon as constituted overstepped their jurisdiction by prosecuting all those practitioners who did not belong to either body, and who constituted the great mass of the practitioners of the healing art. It was necessary, therefore, to pass an act in 1543 for the protection and toleration of these numerous irregular practitioners, to most of whom the term apothecary was applicable, as they usually had shops for the sale of medicines.

In April 1606 James I. incorporated the apothecaries as one of the city companies, uniting them with the grocers. On their charter being renewed in 1617 they were formed into a separate corporation, under the title of the "Apothecaries of the city of London." These apothecaries appear very soon to have begun to prescribe as well as to dispense medicines, which was resisted by the College of Physicians as an encroachment on their rights, but apparently unsuccessfully, as the apothecaries made good their claims. In 1722 an act was obtained empowering the Apothecaries' Company to visit the shops of all druggists who were not members of the company, and to destroy such drugs as they found unfit for use. They appear to have worked this act so rigorously, or rather oppressively, as to put down all druggists who were not members of their body. In 1748, great additional powers were given to the company by an act empowering them to appoint a board of ten examiners, without whose license none should be allowed to dispense medicines in London, or within a circuit of seven miles round it.

In 1815, however, an act was passed which gave the Apothecaries' Company an entirely new position, empowering a board of twelve of their number to have the sole right of examining and licensing apothecaries throughout England and Wales. It also enacted that from the 1st of August that year (excepting those already in practice), none but those licensed by them should have right to practise as an apothecary; and at the same time it was made imperative that candidates for examination should have served a five years' apprenticeship with a member of the company.

As in small provincial towns or villages, no one can practise without keeping a supply of drugs for his patients, this act has given the apothecaries the complete control of the medical profession in England. Every general practitioner must not only have their license, but must have served an apprenticeship with a member of their body. If a practitioner does not dispense drugs the Apothecaries' Company cannot interfere with him.

Before this act came into operation a large proportion of the medical practitioners of England were graduates of the universities of Edinburgh, Glasgow, and Dublin, or licentiates of the Royal Colleges of Physicians or Surgeons—none of whom could attain that status without a full and liberal course of medical education, and undergoing a rigorous examination. This act at once sunk the requirements of the medical practitioner to the lowest ebb; and we have the avowal of the company itself that the course of study required by the company for its license was of a very inferior description. Since 1832, chiefly in consequence of the outcry for medical reform, a much superior course of study has been demanded; but the practical working of the Apothecaries' Act of 1815 has been most hurtful to the medical profession in many respects, and justice demands that the attention of the legislature should be turned to this subject with the view of relieving the most pressing grievances. Though desirable that every medical practitioner should know the drugs he uses, and be able to dispense them, it does not follow that only those are capable of doing this who are licensed at Rhubarb Hall. All those who are recognized in any part of Her Majesty's dominions as regularly licensed practitioners, by possessing the diploma of a chartered licensing medical corporation, should most unquestionably be freed from the operation of this act. Till this be granted, the Apothecaries Act of 1815 must be considered as a foul blot on the Statute Book; and if the medical profession, instead of wasting, as they have done, time and money in the many late vain attempts at a chimerical uniformity of medical education and general union of the whole profession, were to have united for this point alone, it would never have been refused by government, and have relieved them from the only real grievance of which they have to complain. (J. S—K.)

APOTHECA (ἀποθήκη), a storeroom in the upper part of a house, where the Romans frequently kept their wine, in order that the smoke from below might mellow it. Hence the expression in Horace, *Descende, testa. Carm.* iii. 21. 7.

APOTHEOSIS, in *Antiquity*, a ceremony, whereby emperors and great men were enrolled among the gods. The word is derived from ἀπό, and Θεός, *God*. After the apotheosis, which they also called *deification* and *consecration*, temples, altars, and images were erected to the new deity; sacrifices, &c., were offered, and colleges of priests instituted. It was one of the doctrines of Pythagoras, which he had borrowed from the Chaldees, that virtuous persons after their death were raised into the order of the gods; and hence the ancients deified all the inventors of things useful to mankind, and those who had done any important services to the commonwealth.

APOTHESIS (from ἀπό and τίθημι), in the ancient churches, was a place with shelves for holding books, vestments, &c., on the south side of the chancel.

APOTOME, ἀποτομή, in *Geometry*, the difference between two incommensurable lines.

Apotome, a term used by the ancient Greek theoretical writers on musical sounds and intervals to signify that interval in the ratio of 2187 : 2048, which, being cut off from the major tone 9 : 8, left the interval called a limma, λεῖμμα, or minor semitone, in the ratio 256 : 243. Also, the interval 125 : 128 was called a major apotome, and 2025 : 2048 a minor apotome.

APOTROPÆ (from ἀποτρέπω, *I avert*), in *Ancient Poetry*, verses composed for averting the wrath of incensed deities; and the deities invoked for averting any threatened misfortune were called *Apotropaei*. They were also called *Alexicaci*, from ἀλέξω, *I drive away;* and *Averrunci*, from *averrunco*, which denotes the same.

APPALACHIAN MOUNTAINS. See Alleghany.

APPALACHICOLA, a river of Florida, North America, which is formed by the union of the rivers Flint and Chattahouchee, and falls into the Gulf of Mexico after a course of 70 miles. It is navigable for small craft throughout its course. On its banks is a small town of the same name, with a good harbour, and a considerable cotton-trade.

APPANAGE. See Apanage.

APPARATUS, a term used to denote a complete set of instruments, or other utensils, belonging to any artist or machine.—Apparatus is also used as a title of several books composed in the form of catalogues, bibliothecas, dictionaries, &c., for the conveniency of study.

APPAREILLE, in *Fortification*, the slope or ascent to a bastion.

APPARENT Heir, in *Law*. No inheritance can vest, nor can any person be the actual heir of another, till the ancestor is previously dead. *Nemo est hæres viventis*. Before that time the person who is next in the line of succession is called *heir apparent*, or *heir presumptive*. Heirs *apparent* are those whose right of inheritance is indefeasible, provided they outlive the ancestor; as the eldest son or his issue, who must by the course of the common law be heirs to the father whenever he happens to die. Heirs *presumptive* are those who, if the ancestor should die immediately, would in the present circumstances be his heirs, but whose right of inheritance may be defeated by the contingency of some nearer heir being born. In Scottish law, according to Erskine, he who is entitled to enter "heir to a deceased ancestor, is, before his actual entry, styled, both in our statutes and by writers, *apparent heir*, though that application is used sometimes in vulgar speech to denote an eldest son, even before his father's decease."

APPARITION, Circle of, in *Astronomy*, is that part of the heavens in any given latitude within which the stars are always visible, in contradistinction to the circle of occultation.

APPARITIONS.

An apparition may be defined a spectral illusion, involuntarily generated, by means of which figures or forms, not present to the actual sense, are nevertheless depictured with a vividness and intensity sufficient to create a temporary belief of their reality. It is the result of the re-action of an excited imagination, renovating past feeling or impressions, with an energy proportioned to the degree of excitement; arranging them often in new and fantastical groups; and thus surrounding us with a phantasmagoria of the bodiless creation of the brain, so distinct both in outline and lineament, that, while the exciting cause continues to operate, the illusion of reality predominates over the mind with an intensity generally equal to, sometimes greater than, that of the impressions produced by actual perceptions. But although the illusion thus generated is necessarily co-existent with the state of excitement in which it has its origin; or, in other words, ceases to be active when the spectral phenomena vanish; it does not therefore follow that the mind, when it regains its ordinary condition, becomes immediately sensible of the hallucination under which it has for a time been labouring, or capable of distinguishing between the perceptions of sense and the phantasms of imagination. On the contrary, observation proves, what theory equally sanctions, that the conviction of reality generally outlasts the impressions which originally produced it; and that, so far from any suspicion of illusion being entertained, or any power of discriminating the actual from the imaginary being evinced, this conviction takes entire possession of the mind, and, in many instances, maintains its hold with a firmness which all the force of argument and reason is insufficient to overcome. Hence the tenacity, and we may add the universality, of the belief in apparitions; and hence also the prodigious diversity of forms under which these spectral illusions are presented in the popular legends and superstitions of different ages and countries;—a diversity, in fact, which seems commensurate with the incredible variety of influences, whether morbific or other, by which the imagination may be excited, and past feelings or impressions vividly renovated in consequence of its reaction on the organs of sense.

But however this may be, every one must, we think, agree that the subject of apparitions, viewed in connection with the philosophy of the human mind, is one of no mean importance: and, as it has more or less engaged the attention of philosophers from the earliest times, a brief and condensed historical view of the various theories which have been formed to account for these illusions may prove neither uninteresting nor uninstructive; while, in a work of this nature, intended to form a record of the great mass of human knowledge, such an outline appears to be not only requisite, but altogether indispensable.

In the ancient systems of philosophy we meet with the most opposite and contradictory opinions on the subject of spiritual essences, as well as in regard to their supposed occasional manifestations to the eye of flesh and blood. Ocellus Lucanus, one of the earliest of the Greek philosophers whose works have come down to our times, attempts to account for the appearances of the universe by having recourse to eternity and the circle. The circle he conceived to be the appropriate representative of eternity, if not absolutely identical with it; and as form, time, motion, and substance are without beginning and without end, so the universe, of which these are but parts, cannot have been generated, and, for the same reason, must be incapable of corruption. It is in fact a circle, without beginning and without end. But this stupendous circle is divided into parts totally dissimilar, by an isthmus which our fanciful author has placed somewhere in the neighbourhood of the moon, and which forms the boundary between the residence of the gods, where all is invariable, and the material universe, where every thing is in a state of endless change and revolution; the fates having drawn this line of demarcation to separate the passible and corruptible part from that which is impassive and incorruptible, or, in other words, subject to neither motion nor change. The changes on this side of the isthmus, however, are, according to Ocellus, just as endless as the state of things beyond it is immutable; for these changes revolve in a circle, which has neither beginning nor end, and consequently must be eternal; and hence the only difference between the two unequal compartments is, that, in the one, every thing is in a state of eternal rest, while, in the other, all is motion and revolution without end. It seems to follow, therefore, that the fates, in tracing this line of demarcation, have excluded the gods from all control over the material or corruptible part of the universe; and that the existence of an immortal essence, in the midst of the confusion of our lower world, is wholly impossible. Yet, in his fourth book, Ocellus speaks of the Deity conferring instincts and appetites on man: and, in a fragment preserved by Stobæus, he says that life is that which holds the body together, and that the cause of life is the soul; that the world is held together by harmony, and that the cause of harmony is the Deity; that states are held together by agreement, and that the cause of this agreement is the law;—sentiments which seem strangely at variance with the transcendental doctrine of eternity and the circle, by which all the varied phenomena of the universe were to be explained.

The atomic theory of Democritus, which some have recently attempted to revive, was adopted with certain modifications by Epicurus, and has been explained and illustrated by Lucretius in his philosophical poem on the *Nature of Things;* in which he enters with ardour and enthusiasm into the views of his favourite master, assails his enemies with the bitterest invective, combats every objection and difficulty, palliates and mystifies what cannot be defended, and pours forth his whole genius in support of the system which Democritus imagined and Epicurus taught. But neither the numbers nor the ingenuity of the poet have succeeded in recommending to any rational mind a theory based on the most extravagant assumptions, and involving consequences subversive of all those checks and restraints by which society is held together. At the same time, Lucretius is the first ancient writer who makes a formal attack on the popular notions entertained respecting ghosts and apparitions. These he justly regards as complete illusions; and maintains, conformably to the philosophy of Democritus and Epicurus, that so far from being spirits returned from the mansions of the dead, they are nothing more than attenuated films, pellicles, or membranes, cast off from the surface of all bodies, like the *exuviæ* or sloughs of reptiles;[1] or, in other words, the mere shadows

[1] It is often amusing as well as instructive to trace the history and descent of opinions. The strange notion of Lucretius, that apparitions are subtile films or images rising from the surfaces of bodies, appears to have entered more or less into many of the systems

Apparitions.

of things which fear, and its offspring superstition, mistake for realities. The world, he observes, has long been in a state of horror and despair from dread of these incorporeal beings; and he acknowledges that his principal object, in expounding the doctrines of his master, is to rescue mankind from their vain apprehensions, by showing that all things are corporeal and dissoluble, not even excepting the soul itself; and thus destroying that *pneumatophobia* which, to use the language of Cudworth, makes men "have an irrational but desperate abhorrence from all spirits or incorporeal substances." Philosophy cannot certainly be better employed than in endeavouring to emancipate the mind from the unreal terrors by which it is so frequently enslaved. But it can scarcely fail to be a subject of regret that the philosophers of the Epicurean school should have sought to accomplish a laudable end by the intervention of means alike absurd and pernicious. Material necessity, and by consequence atheism, is at the root of all their doctrines; nor can these, therefore, be admitted to be true without overwhelming religion in the same ruin with superstition. Hence they are chargeable with the grievous fault of striking at a mass in order to reach an individual; of attempting to hew down the trunk in order to clear away a withered branch. At the same time they have the unquestionable merit of being the first who endeavoured, however unsuccessfully, to account, upon natural principles, for those appearances, which have in all ages more or less excited the fears and mingled with the superstitions of mankind.

But, without dwelling on particular systems of philosophy, we may observe generally, that although the belief in spectres or phantasms appears to be as old as the existence of the human race, this belief has in every instance been modified, and we may almost say regulated, by the prevalent pneumatological opinions respecting the soul, whether these have been derived from the writings of philosophers and poets, or imbibed from sources purely mythological. Strictly speaking, indeed, the character of superstitious credulity has been in all ages the same; but it is nevertheless true, that its particular objects have varied, as the opinions of mankind have changed respecting the sentient principle or cause of the vital phenomena.

In the case of the Greeks and Romans this is peculiarly remarkable; inasmuch as their superstitions afford ample evidence of the diversity of opinion that prevailed regarding the soul, yet are all more or less tinctured with its predominant colour and complexion. Democritus and Epicurus, as we have seen, considered it corporeal, but differed widely as to its substance; the Stoics maintained that it was ignited air; Hippo held that it was water; and Heraclitus was of opinion that, as the *anima mundi*, or soul of the world, was a vapour or exhalation from the moist elements, so the souls of animals were vapours or exhalations from their own bodies, or something external. Of those, again, who believed the soul to be incorporeal, some maintained that it was a substance, and immortal, while others asserted that it was neither. Thales taught that it was always in motion, and itself the origin or cause of that motion; Pythagoras regarded it as a self-moving monad or number; Plato thought it a substance conceivable only by the understanding, and moving according to harmony and number; Aristotle described it as the first *entelecheia*, or, to use the language of the translator of Nemesius, "the first continuall-motion of a bodie-naturall, having in it those instrumental parts, wherein was possibility of life;" and Dinarchus considered it a harmony of heat, cold, moisture, and dryness, or, in other words, a contradiction. Some imagined that there is but one universal soul, distributed in portions throughout all bodies, animate and inanimate, which doctrine was subsequently adopted by the Manicheans; while others taught that there is indeed one universal soul, but at the same time many different species. The illustrious head of the Platonic school seems to have believed in the existence of an universal soul, by means of which all things were supported in being; but he conceived that those only were to be accounted living creatures which had separate souls. The doctrine of transmigration was a natural consequence of these opinions, and, what is not a little remarkable, it seems to have been generally received among those philosophers who believed most firmly in the immortality of the soul; some making it pass indiscriminately into the bodies of plants and animals; others, into all organized structures; while a third set, conceiving that every kind of soul, whether rational or irrational, has a structure exactly suited to its own faculties and no other, confined it to structures of the same species. Plato distinguished these faculties into three classes, the vegetative, sensitive, and rational; and assigned a separate residence to each, the habitation of the last being, according to him, in the head.

Indeed the practice of arranging the logical entities, known by the names of *powers*, *faculties*, or *functions*, into different classes, and ascribing them to different species of souls, appears to have been prevalent at an early period, both among philosophers and poets. Empedocles allotted a rational and a sensitive soul to every animal; the rational one being derived from the gods, and the sentient a product of the four elements. But the ancients generally reserved the rational soul for man. In Homer's time the soul was divided into two species, the φρην and the θυμος, but afterwards, according to Diogenes Laertius, into three; while the body was considered tripartite, being composed of a mortal or crustaceous part,—a divine, ethereal, or luciform portion, appropriated to the φρην,—and an aerial, misty, or vaporous part, allotted to the θυμος. After the dissolution of the mortal part, however, the φρην was entirely separated from the θυμος, and a different habitation assigned to each. Hence we learn from Homer, that the φρην of Hercules was actually feasting with the gods, and making love to Hebe, at the very time that Ulysses was conversing with his θυμος in Hades. Similar notions were entertained by the Roman poets. According to them, every man possessed a threefold soul, which, after the dissolution of the body, resolved itself into the *Manes*, the *Anima* or *Spiritus*, and the *Umbra*, to each of which a different place was assigned. The Manes descended into the infernal regions, to inhabit

on the same subject taught by the schoolmen in the middle ages, although the latter have not always remembered to acknowledge their obligations to the Roman poet. A similar view may also be detected in the reveries of the sympathetic philosophers, and particularly in the theory of the transmission of spirits propounded by Lavater; nor are there wanting traces of its existence in the popular superstitions both of ancient and modern times. Some of the older philosophers, on the other hand, appear to have construed the Epicurean doctrine of corporeal images much more literally than its great poetical expounder seems to have intended. Psellus, for instance, stoutly contends for the heretical doctrine of the materiality of demons, in which he seems to have been a stanch believer. Paracelsus, conceiving that the elements were inhabited by four kinds of demons—spirits, nymphs, pigmies, and salamanders—argues, in like manner, for the materiality of these non-descript beings, but seems inclined to think that they possessed *caro non-adamica*, which may easily be conceded to him. Cudworth maintains the materiality of angels; and some of his successors, improving upon their models, contend for the materiality of every thing in heaven above or in the earth beneath; thus completing the cycle of absurdity, and bringing us back at last to the Epicurean doctrine, from which we set out.

either Tartarus or Elysium; the Anima ascended to the skies, to mingle with the gods; while the Umbra hovered around the tomb, as if unwilling to quit its connection with the body, of which it was the *wraith* or shadow. Hence Virgil represents Dido, when about to expire, as threatening to haunt Æneas with her *umbra*, at the same time consoling herself with the expectation that the tidings of his punishment will reach her *manes* in the shades below.[1] Nor are there wanting traces of an analogous belief in the popular superstitions of modern times. It is an article of ghostly faith, that apparitions are frequently seen near the spot where the gross or crustaceous body lies, waiting either until that body be interred, or until some crime be confessed and expiated; and, if tradition may be in aught believed, the spectral appearances of individuals have occasionally been observed previous to their death, of which, indeed, these illusions are the sure forerunners or harbingers. Among the Greeks such spectres were denominated φαντασματα, πνευματα, ειδωλα, apparitions, aerial forms, likenesses; while the Romans called them *spectra, umbræ, simulacra, manes, imagines*, visions, shades, similitudes, ghosts, and images.

Some, however, thought that spectral illusions were souls visibly expanded; but others doubted whether they were ψυχαι, the principles of life, or merely the vehicles of such principles. The ghost of Hercules, which Ulysses saw in Hades, was, according to Homer, his ψυχη and ειδωλον, or his corporeal likeness, animated by his θυμος; and such *simulacra* were supposed to speak, to complain, to feel hunger, and to receive nourishment, though probably at that table only where spare fast diets with the gods. It may also be observed, that, according to Virgil, the *umbræ* were the *animæ* or souls themselves, and were all sprung from the same source as the soul of the universe, namely, from ether or elemental fire. Hence, the *umbræ* which Æneas beheld in the shades below, when he went thither to visit his father Anchises, were ethereal souls, receiving rewards or suffering punishments for their past deeds; some for inexpiable crimes, which rendered their punishments eternal; others for offences, the stains of which might be obliterated, and who, consequently, were exposed for a series of ages to the action of air, water, or fire, " until the crimes done in their days of nature were burned and purged away." At the same time, it is quite true, as Dr Barclay has remarked, that " in most, if not in all of these *simulacra*, the dress and its fashions were represented as well as the body; while, in all the poetical regions of the dead, chariots and various species of armour were honoured likewise with their separate *simulacra;* so that these regions, as appears from the *Odyssey, Æneid*, and *Edda*, were just the *simulacra* of the manners, opinions, customs, and fashions, that characterized the times and countries in which their poetical historians flourished."[2]

To the superstitions of Greece and Rome we are also indebted for those subordinate spirits named *demons* or *genii*, who for many centuries were the subject of numberless spectral illusions. These intermediate beings were distinguished by the Platonists from the superior deities of the popular mythology on the one hand, and from heroes or demigods on the other. They were divided into beneficent and malignant spirits; and, according to the conceptions of the Platonic philosophers, differed in no material degree from the good and evil angels of the Christian belief. Socrates fancied himself constantly attended by a demon or genius, to whose inspirations or suggestions he conceived himself indebted for those views of practical wisdom and philosophy which have rendered his name so deservedly illustrious. Among the Romans, again, genii were supposed to be messengers of the gods, employed, on particular occasions, to give intimation to men of approaching events, or calamities soon to befall them. Of this kind was the phantasm which appeared to Brutus sitting dejected in his tent, and told him that they would meet again at Philippi.[3] Cornelius Sylla received a similar intimation from an apparition, which accosted him by his name: and, concluding that his death was at hand, the ex-dictator prepared himself for the event, which took place the following evening, in consequence of a sudden and violent attack of fever. Cassius Severus, the poet, a short time before he was slain by order of Augustus, saw, during the night, a human form of gigantic size, with his skin black, his countenance squalid, his beard grizzled, and his hair dishevelled; a phantasm not unlike the evil genius so powerfully described by Lord Byron as appearing to Manfred in the hour of his agony.[4] The emperor Julian, on

[1] This notion of a threefold soul is well expressed in the following lines, attributed to Ovid:—

> Bis duo sunt homini: *Manes, Caro, Spiritus, Umbra:*
> Quatuor ista loci bis duo suscipiunt;
> Terra tegit *Carnem*, tumulum circumvolat *Umbra*,
> Orcus habet *Manes, Spiritus* astra petit.

[2] *Inquiry into the Opinions, ancient and modern, concerning Life and Organization*, p. 14. By John Barclay, M. D. Edinb. 1822, 8vo.

[3] The observations of Sir Walter Scott on the spectre which appeared to Brutus on the eve of the battle of Philippi are equally just and philosophical, in so far as regards the exciting cause:—" The anticipation of a dubious battle, with all the doubt and uncertainty of its event, and the conviction that it must involve his own fate, and that of his country, was powerful enough to conjure up to the anxious eye of Brutus the spectre of his murdered friend Cæsar, respecting whose death he perhaps thought himself less justified than at the Ides of March, since, instead of having achieved the freedom of Rome, the event had only been the renewal of civil wars, and the issue might appear most likely to conclude in the total subjection of liberty. It is not miraculous that the masculine spirit of Marcus Brutus, surrounded by darkness and solitude, distracted probably by the recollection of the kindness and favour of the great individual whom he had put to death to avenge the wrongs of his country, though by the slaughter of his own friend, should at length place before his eyes in person the appearance which termed itself his evil genius, and promised again to meet him at Philippi. Brutus' own intentions, and his knowledge of the military art, had probably long since assured him that the decision of the civil war must take place at or near that place; and allowing that his own imagination supplied that part of his dialogue with the spectre, there is nothing else which might not be fashioned in a vivid dream or a waking reverie, approaching, in absorbing and engrossing character, the usual matter of which dreams consist. That Brutus, well acquainted with the opinions of the Platonists, should be disposed to receive without doubt the idea that he had seen a real apparition, and was not likely to scrutinize very minutely the supposed vision, may be naturally conceived; and it was also natural to think, that although no one saw the figure but himself, his contemporaries were little disposed to examine the testimony of a man so eminent, by the strict rules of cross-examination and conflicting evidence, which they might have thought applicable to another person and a less dignified occasion." (*Demonology and Witchcraft*, p. 10, 11.)

[4] The description alluded to in the text is as follows:—

> I see a dusk and awful figure rise
> Like an infernal god from out the earth;
> His face wrapt in a mantle, and his form
> Robed as with angry clouds; he stands between
> Thyself and me, but I do fear him not.

one occasion, while engaged in an expedition, beheld a spectre or apparition clad in rags, yet bearing in its hands a horn of plenty, covered with a linen cloth; and thus emblematically attired, the spirit stalked mournfully past the hangings of the Apostate's tent. Lastly, Dio of Syracuse was visited by one of the Furies in person, not in the shape of a vixen, but of a horrid phantasm, the appearance of which was considered by the soothsayers indicative of the death of his son (which occurred soon after), as well as of his own approaching dissolution. Many other instances might be given of similar illusions, evidently conjured up by the workings of an excited imagination re-acting on the organs of sense, and believed to be harbingers of "coming events;" but those we have mentioned are sufficient to show the opinions entertained in regard to such apparitions, and to exemplify the power which superstition exercises over the mind when unenlightened by a sound and rational philosophy. We may add, however, that demons or genii were frequently regarded as private monitors, who by their insinuations disposed each man to good or evil actions, and were not only reporters of his crimes in this life, but registrars of them against his trials in the next; an opinion which the Romans evidently derived from the Greeks, among whom a similar notion prevailed from an early period of their history.

Among the Jews and early Christians we find analogous superstitions, though, as might have been expected, much more varied and complex in their details. Like the Greeks and Romans, the Jews believed in good and evil spirits, to the latter of which the name of demons came to be exclusively appropriated; and this belief they founded partly on the statements contained in their own Scriptures, partly on notions derived from the Pagans. Some of their angels were supposed to be created out of the elements of fire, others out of the wind; and both classes forfeited their immortality whenever they issued from their allotted place. Their business was to instruct mankind in wisdom and knowledge; and every thing in the world was conceived to be under their government. Even to the herbs of the field, supposed to exceed twenty thousand in number, presiding angels were assigned; and rain, hail, thunder, lightning, fire, fishes, reptiles, animals, men, cities, empires, nations, were all respectively under the dominion of spiritual powers. Nor were their demons less numerous than their tutelar genii or angels, as any one may easily satisfy himself by consulting the Talmud, in which this multitudinous array of spirits is very minutely described. Every form of evil, whether physical or moral, was ascribed to the direct agency of one or other of this subordinate tribe of devils, whose sole business it was to work mischief, and who were also conceived to be indefatigable in the exercise of their calling; so much so that, in the constant warfare carried on between the good and evil spirits, it is far from being clear that the former had always the advantage. Demoniacal possession is only one form under which this infernal agency manifested itself. In a word, the superstitious Jew who devoutly believed in the wild vagaries engendered by the seething imaginations of the Rabbin, might have said with the Roman satirist, *Nostra regio tam plena est numinibus, ut facilius possis deum quam hominem invenire.*

It is not to be wondered at, however much it may be regretted, that many of these notions accompanied the spreading of the gospel, and communicated a taint of Jewish superstition to the faith of the first Christians. The mind is unable at once to emancipate itself from the dominion of delusions, which have been consecrated by time and sanctioned by authority, and which, insensibly imbibed by education and habit, address themselves to the natural fears and feelings of the human heart. Hence it ought not to surprise us that, not only at the commencement of the Christian dispensation, but during a very long period afterwards, evident traces may be discovered of the prevalence of the popular opinion mentioned by Symmachus, namely, "that the Divine Being had distributed to cities various guardians, and that as souls were communicated to infants at their birth, so particular tutelary spirits were assigned to particular societies of men." On the other hand, some sects, puzzled to account for the origin of evil, and affecting philosophy without possessing a philosophical spirit, systematized the Jewish superstitions, by combining them with the creed of Zoroaster, and promulgating formally the doctrine of a ceaseless antagonism between the good and evil principles, personified in the Ormusd and Ahriman of the Persian mythology; while others, again, imitating the classification of the different orders of spirits by Plato, attempted a similar arrangement with respect to the hierarchy of angels.[1] Both systems involved the constant agency of spiritual power in the government of the world, and admitted also its occasional manifestation in the shape of apparitions. Among the Fathers, however, great diversity of opinion prevailed in regard to these illusions, which no one seems to have dreamt of attempting to explain by reference to natural causes. Origen, for example, conceived that souls, tainted with the guilt of flagrant crimes, and not purged from their impurity, were either confined in a species of limbo, or attached to particular spots, where, within certain limits, they might ramble about at will. Athanasius maintained that souls, when they were once released from their bodies, held no more communion with mortal men; and the more rational of the early theologians condemned all visions and apparitions that had not the unequivocal sanction of the Deity, our Saviour, or the angels. Augustin also remarked that, if souls did actually walk and visit their friends, he was convinced his mother, who had followed him by land and sea, would have shown herself to him, in order to inform him what she had learned in another state, as well as to give him much useful advice Others, however, yielded to the current superstitions, which they laboured to reconcile with the doctrines and statements of Holy Writ.

But it was not until a much later period of Christianity that more decided doctrines were established relative to the origin and nature of demons; and it is principally to the Papal Church of Rome that the unenviable honour is due, of adopting and methodizing the vagaries of the Pagans, as well as the legends of the Talmud, and thus originating that system of demonology which, from various causes, grew to such a monstrous height during the middle ages, as completely to overwhelm Christianity under its revolting and abominable fictions. When this church recognised the doctrine, that the functions of ministering angels were assigned to the spirits of departed saints, she opened a door for the admission of the abominations of Paganism in a new form,[2] and the encouragement of su-

[1] We allude to the Gnostics, according to whom the gradations in the hierarchy of angels stood thus:—The first and highest order was named seraphim, and the second cherubim; the third was the order of thrones, and the fourth that of dominions; the fifth was the order of virtues, the sixth of powers, the seventh of principalities, the eighth of archangels, and the ninth or lowest that of angels. This fable, as Dr Hibbert remarks, was pointedly censured by the apostles; yet, nevertheless, it outlived the pneumatologists of the middle ages, and is scarcely even now exploded.

[2] It is impossible not to feel that the reproaches which Reginald Scot casts upon the church of Rome, on account of her heathenism, are well merited, and that their chief bitterness is not so much in the unrelenting irony of that dauntless writer, as in

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perstitions, utterly subversive of all true religion; while, on the other hand, by countenancing and fostering the frantic extravagances of the demonologists, more particularly in regard to the impossible crime of witchcraft, she did all in her power to perpetuate the empire of delusion, and at the same time made herself responsible for the multiplied atrocities which were committed under its influence. She became, in fact, the nursing mother of lies, and the avowed patroness of the powers of darkness. The devil and his legions were everywhere and in every thing: diabolical agency was supposed to be unremitting and universal. The priests strengthened their dominion by practising conjurations and exorcisms; while the monks fabricated legends suited to the prevailing taste, and calculated to thicken the delusion which added so greatly to their spiritual power. In the meanwhile Satan's invisible world was displayed with a topographical minuteness of detail, which could scarcely have proved very agreeable to that great personage. The nature, history, and rank of devils were curiously inquired into, and the point of precedency in the infernal hierarchy settled to a nicety; the various forms assumed by them in the course of their operations upon earth were also very fully described; the different tests by which their presence might be detected were given with something like scientific precision; and, what is still more extraordinary, the number of these fallen spirits was determined to a fraction. In short, the wildest fictions which imagination ever coined were gravely received as matters of faith and doctrine; while a new impulse and direction were thereby given to popular superstition, which the ghostly legends of the Church had far outstripped in point of extravagance.

At this period, accordingly, the belief in apparitions was universal, and people would have sooner doubted their own existence or identity, than ventured to call in question the most grotesque fooleries which the human fancy ever imagined. Even the Reformation, which overthrew so many errors, eradicated so many prejudices, and destroyed so many delusions, left this one as hideous as ever. And so far from proving himself superior to the vain imaginations and follies of his time, Martin Luther has left abundant evidence to show, that he was as deeply imbued with superstitious credulity, and believed as firmly in diabolical apparitions, as the most illiterate monk in the church which he shook to its very foundations. He even fancied that the devil took a particular pleasure in annoying him, doubtless from pique at the successful resistance he had opposed to the power and pretensions of Rome; and he relates several conversations, or rather altercations, he had had with the Evil One, in which, by his own showing, the reformer had clearly the best of it (so far at least as abuse was concerned), and generally ended by putting the fallen spirit to flight. On one occasion in particular, when the Tempter had intruded himself rather unseasonably, and had chosen to assume "a glorious form of our Saviour Christ," the reformer, who at first expected a revelation, lost all temper as soon as he discovered the real character of his visitant, and exclaimed fiercely, "Away, thou confounded devil; I know no other Christ than he that was crucified, and who, in his word, is pictured and preached unto me; whereupon," he adds, "the image vanished, which was *the very Devil himself*." And all his narratives of losses or misfortunes which happened to individuals in whom he felt an interest commonly end with the pithy solution, "This did the devil."[1] Nor was he at all singular in entertaining these notions, which in fact were equally shared by the other reformers, and continued long afterwards to exert a most powerful influence upon the faith of all Europe; particularly in regard to the imaginary crime of witchcraft, for which so many unhappy wretches suffered death both in this and in other countries.

It would be vain to inquire whether, at the period in question, or indeed for a long time afterwards, any attempt was made to expose the impostures which were continually practised, or to account, upon rational principles, for those spectral illusions which are known to be generated in particular states of the body and mind. Such an idea seems never to have entered the head of any one; and indeed if a sceptic had arisen bold enough to insinuate even a suspicion of the fallacy of the received opinions, he would have been sacrificed without mercy to the bloody Moloch, who was then the object of almost universal homage. He might perhaps have denied his God, and blasphemed his Saviour with impunity; but if he had dared to dispute the agency of the Devil, to doubt the reality of his appearances, or in any manner of way to assail the creed of the

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their truth. "Surelie," says he, "there were in the Popish church more of these antichristian gods in number, more in common, more private, more publicke, more for lewd purposes, and more for no purpose, than among all the heathen, either heretofore or at this present time; for I dare undertake, that for everie heathen idol I might pronounce twenty out of the Popish church. For there were proper idols of every nation, as St George on horseback for England, St Andrew for Burgundie and Scotland, St Michael for France, St James for Spain, St Patrike for Ireland, St Davie for Wales, St Peter for Rome and some part of Italie. Had not every citie in all the Pope's dominions his severall patrone; as Paule for London, Denis for Paris, Ambrose for Millen (Milan), Louen for Gaunt, Romball for Mackline, St Mark's Lion for Venice, the three magician kings for Cullen, and so of other? Yea, had they not for everie small towne and everie village and parish (the names whereof I am not at liberty to repeat) a severall idol: as St Sepulchre for one, St Bride for another; St All Hallowes, All Saints, and Our Ladie for all at once? Had they not hee idols and shee idols, some for men, some for women, some for beasts, and some for fowels? And do you not thinke that St Martine might be opposed to Bacchus? If St Martine be too weak, we have St Urbane, St Clement, and manie others to assist him. Was Venus and Meretrix an advocate for whores among the Gentiles? Behold, there were in the Romish church to encounter them, St Aphra, St Aphrodite, and St Maudline. Was there such a traitor among the heathen idols as St Thomas Becket? or such a whore as St Bridget? I warrant you, St Hugh was as good a huntsman as Anubis. Was Vulcane the protector of the heathen smithes? Yea, forsooth, and St Euloge was patron for ours. Our painters had Luke, our weavers had Steven, our millars had Arnold, our potters had St Gore with a devil on his shoulders and a pot in his hand. Was there a better horseleech among the gods of the Gentiles than St Loy? or a better sow-gelder than St Anthonie? or a better tooth-drawer than St Apolline? I believe that Apollo Parnopeius was no better a rat-catcher than St Gertrude, who hath the Pope's patent and commendation therefore." And so honest Reginald proceeds with his expostulatory comparison, which, in the true spirit of his age (when the phantasms of demonology maintained their dominion even over those minds which had cast off the fetters of the church of Rome), he concludes by declaring that "all these antichristian gods, otherwise called popish devils, are as rank devils" as any that are spoken of in the Psalms, or mentioned in other parts of Scripture. (See *Discourse on Devils and Spirits*, appended to the *Discourse of Witchcraft*.)

[1] Mr Coleridge, in his *Friend*, vol. ii. p. 336, gives the following natural and rational account of the origin of Luther's visions:— "Had Luther been himself a prince, he could not have desired better treatment than he received during his eight months' stay in the Wartzburg: and in consequence of a more luxurious diet than he had been accustomed to, he was plagued with temptations both from the 'flesh and the devil.' It is evident from his letters that he suffered under great irritability of his nervous system, the common effect of deranged digestion in men of sedentary habits, who are at the same time intense thinkers; and this irritability adding to and vivifying the impressions made upon him in early life, and fostered by the theological systems of his manhood, is abundantly sufficient to explain all his apparitions, and all his mighty combats with evil spirits."

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demonologists, it would have been better for him that a mill-stone had been hanged about his neck, and he had been cast into the midst of the sea. On the gibbet or at the stake, he would infallibly have expiated the audacity of his unbelief. In process of time, however, humanity began to lift up her voice, and reason seemed to recover from the long trance into which the reign of delusion had thrown her. Scattered rays of light broke in from various quarters; as knowledge advanced, the mind became expanded; a spirit of inquiry was gradually developed; the learned began to reason and to doubt; and the empire of superstition was shaken. For long, the vulgar creed, which had been deeply tinged with the monstrosities and follies we have alluded to, resisted the influence of the causes which were now at work, sapping the foundations of the whole edifice of delusion; and even yet, amidst all the light with which we are surrounded, some corners of the world still remain unilluminated. But a change had come over the spirit of the dream in which the nations had so long been entranced; and men, having begun to examine, soon learned to doubt and disbelieve.

About the end of the sixteenth and beginning of the seventeenth century, various theories were suggested to account for those extasies of imagination in which spectral illusions have their origin; and, in the memorable experiment of palingenesis, or the resurrection of plants (a secret known to Digby, Kircher, Schot, Gafferel, Vallemont, and others), an explanation was sought of apparitions, which were thought to be reproduced in a similar manner. To this succeeded the doctrine of astral spirits, as they were called; which was an attempt to combine the metaphysical opinions then entertained respecting ideas, with the conclusions deduced from the experiment of palingenesis, or the reproduction of a rose, like the phenix from its ashes. Others, again, referred all the phenomena of extasies, hallucinations, and apparitions to the phantasy or imagination, which was justly conceived to exert a powerful influence over the mind, and to be primarily concerned in the production of those illusions which give birth to a belief in apparitions. Van Helmont, Hoffmann, and most of the medical inquirers of that age, adopted this explanation; and several passages in Hamlet show that such was also the belief entertained by our immortal dramatist. If the imagination, it was argued, can induce a particular form or mark upon the fœtus in the womb, much more must it be capable of vivifying and clothing ideas in the mind so as to create an illusion of reality. Nor were these inquiries confined to apparitions alone. In the year 1701 the celebrated Thomasius distinguished himself by an inaugural dissertation *De Crimine Magiæ*, in which he attacked, with irresistible force of reasoning, the prevalent belief in witchcraft, and boldly exposed the insane and murderous delusions which had conducted whole hecatombs of victims to the stake. This thesis, embodying a formal attack on demonology, was publicly read in the university of Halle, which, to its honour, greeted with applause the bold scepticism of the young jurisconsult; and so well did the latter perform his task, that his juvenile production is still considered valuable, both for its facts and its reasonings.

The approbation with which the inaugural dissertation of Thomasius was at first received, and the merited celebrity which it subsequently obtained, may be considered as proofs that more rational opinions had already begun to prevail, at least among the learned; and that the minds of men were in some measure prepared for the reception of the new doctrines he so fearlessly promulgated. Popular credulity, indeed, still continued gaping and greedy: it still yearned, with an unabated craving, for the supernatural and the diabolical. But the softening and humanizing influence of knowledge had imperceptibly mitigated the ferocity which the belief in demonology had originally inspired; and, although the public generally were not more enlightened or less superstitious, the magistrate had insensibly become more humane, and the fires of persecution burned less frequently and fiercely. The tide, in short, had obviously turned; and the first indication of the reflux is afforded by the justly-celebrated discourse in question.

At the same time, Thomasius, though among the foremost, was not the first, to assail demonology. This honour of right belongs to Dr Balthasar Bekker,[1] a protestant clergyman at Amsterdam, and author of a learned

[1] Balthasar Bekker was a native of Metselawier in Friesland, where he was born in the year 1634. He had no other master than his father, who was the pastor or clergyman of the place, until he attained the age of sixteen, when he went to prosecute his studies at Groningen, and afterwards at Franeker. In the first of these universities Alting was his master in Hebrew, and conceived a strong affection for his pupil, whom he subsequently supported against his numerous enemies and persecutors. Having completed his studies at Franeker, Bekker was appointed rector of a Latin school, and afterwards pastor at Ooterlitten, where he signalized himself by his zeal in the discharge of his duty, and in consequence drew down upon himself the enmity of his less active colleagues. In 1666 he took the degree of Doctor of Divinity at Franeker, together with the situation of pastor, and soon afterwards published a tract entitled *De Philosophia Cartesiana Admonitio Sincera*, in which he attempted to prove that the Cartesian philosophy, a taste for which he was anxious to diffuse, might be easily allied with the study of theology. This piece appears to have procured him nothing but enemies, the number of whom was considerably increased by the publication, about the same period, of two catechisms, under the absurd titles of *Gesneden Brood* and *Vaste Spyze*; in the last of which he advanced some peculiar opinions concerning the state of Adam before his fall, the nature and duration of the pains of hell, the ecclesiastical hierarchy, and the rights of ecclesiastical assemblies. His jealous colleagues accused him of Socinianism and Cartesianism; and although he wrote a defence of his opinions, and showed a disposition to alter or retract every thing that might be conceived contrary to the faith, the synod, disregarding his concessions, prohibited the printing of the *Vaste Spyze* under a severe pecuniary penalty. Chagrined at this proceeding, he quitted Franeker, and became successively pastor at Loenen and Wesop, chaplain of a regiment of the line, and finally, in 1679 established himself at Amsterdam, where new writings soon kindled up afresh the animosity of his brethren. He combated the prejudices of the vulgar in a tract which he published on the occasion of the appearance of a comet in 1680 and 1681; and, in his *Recherches sur les Comètes*, published in 1683, he adopted a course of argument similar to that pursued by Bayle, showing that comets are neither presages nor forerunners of calamities, as was then currently believed, and ridiculing the popular notions and superstitions on this subject. This little work, replete with sound and just ideas, was well received. But a very different fate awaited another and far more important one, which he published soon after, under the title of *De Betooverde Wereld*, or *The World Bewitched*; a performance which justly entitles him to be ranked with the freest, boldest, and most philosophical thinkers which any age or country has produced. *De Betooverde Wereld* was first printed at Franeker, and afterwards reprinted several times at Amsterdam, where a French translation, in four volumes 12mo, appeared in 1694; and a new edition was published at Deventer so late as the year 1737. This work, which had the misfortune to appear too soon, is the one which has most contributed to render Bekker's name famous, both from its own intrinsic merits, and from the fury of calumny and persecution to which it exposed him. If formerly he was regarded as a Cartesian and Socinian, he was now denounced as a downright Sadducee. All pens were in motion against him; and before Bekker had time to reply to the host of adversaries by whom he was assailed, his book was submitted to the censure of the ecclesiastical council. The author published a defence or apology, *Schriftelike Satisfactie*, in which he protested against all malignant interpretations of his book, and avowed his belief in the existence of the devil, but at the same time expressed his conviction that

work, first published in Dutch and afterwards in French entitled, *The World Bewitched, or an Examination of the Common Opinions concerning Spirits, their Nature, their Administration, and their Operations, and also concerning the Effects which Men are capable of producing by their Intercourse and their Virtue:* a work which Thomasius must in all probability have seen and consulted, as the French edition appeared in 1694, ten years prior to the publication of his thesis; and the persecution which the author experienced on account of his scepticism about devils and their supposed operations could scarcely fail to make it generally known. But be this as it may, the performance of the Dutchman is certainly an extraordinary one for the time at which it appeared; being not more remarkable for the learning it displays than for the boldness with which it combats the received opinions regarding spirits, and the exceeding ingenuity with which the various frauds and impostures of the demonologists are detected and exposed.

The author sets out by giving an able and accurate exposition of the opinions, or rather fables, of the Pagans, Jews, and Mahometans, on the subject of demons, or good and evil spirits, with their supposed attributes, functions, and operations, as described in their different mythological systems, and particularly as received at the period when Christianity was first preached to the world. He then proceeds to show that the early Christians insensibly introduced and mixed up with the new faith many of the fictions of Paganism and Judaism; and that this corrupting process went on continually increasing, until it attained a maximum under the Papacy, when all the miracles which the Pagans had supposed to have been performed by their demons or inferior divinities were ascribed to angels, to the souls of sinful men, and, above all, to the power of the devil. In particular, he traces the progress of Manicheism, from the time when it first assumed consistency and form; and shows, in a very striking manner, how this heresy, though anathematized by the Church, gradually insinuated itself into the very core of all her doctrines respecting spiritual agency in human affairs; and thus became part and parcel of the creed which she ordained men to believe under the penalty of eternal damnation. It is to this unfortunate intermixture of Paganism with Christianity, therefore, that he ascribes all the abominations with which the latter was polluted; and hence he contends, " que plus on se trouve éloigné du Paganisme, soit pour le temps, soit pour les lieux, moins on ajoute de foi à toutes les choses qui regardent le diable et son pouvoir." But his great principle is, that the doctrines of the demonologists are not more repugnant to reason, than adverse to Scripture when rationally interpreted. Revelation, he holds, contains nothing to sanction such doctrines; and he supports this opinion by a detailed examination of all the cases mentioned in holy writ where the devil is either represented as appearing to men, or exercising an immediate power over their bodies or minds,—explaining them on rational or natural principles with singular skill and ingenuity. For example, he rejects as absurd the idea of demoniacal possession, though generally received by the Protestant as well as the Catholic Church; and regards the cases of *dæmonia* mentioned in the New Testament as not properly " une expulsion des diables, mais une guérison miraculeuse de maladies incurables." Again, with regard to the metaphysical doctrine of the demonologists, " qu'un esprit en tant qu'esprit, et d'autant plus même qu'il est un esprit, peut sans corps agir sur toutes sortes de corps et sur les autres esprits," he does not meet it by a direct denial, but calls upon his adversaries to prove their own fundamental proposition. " Je demande des preuves de cette thèse," says he, in his *Abrégé* and *Défense;* " et parce que cette demande est imprévue et extraordinaire, et sur laquelle par conséquent on ne s'étoit préparé, on prend ma demande pour une négative.—I do not deny the truth of it, if it be true, but neither can I admit the truth of it till it be proved, nor can you assume it without proof, and then call upon others to believe it." Upon the same principle he demonstrates the utter absurdity of all supposed compacts with the devil, which he considers as not more impossible in themselves than incapable " subsister, en aucune manière, avec ce qui est contenue dans la doctrine de l'Ecriture, ni avec l'économie de l'alliance de Dieu, tant avant la Loi que sous la Loi, et moins encore sous l'Evangile."

But the most interesting part of this curious work, perhaps, is that where the author exposes, with equal skill and severity, the various frauds and impostures which have been practised upon ignorant credulity, and have thus given rise to all the delusions of witchcraft, and to a vast majority of those on the subject of apparitions. He examines in detail a great number of cases of both descriptions, and never fails to detect and drag to light the deception in which they originated. He exhibits a commerce of imposture and dupery, of fraud and credulity, often amusing, always instructive, sometimes truly horrible with reference to its consequences. In short, his exposure is complete and triumphant. " Les diables qui se faisoient voir et entendre," says he, " étoient dans la cervelle des hommes; si non, ils étoient faits de chair et d'os;" and he holds, " qu'il n'y auroit point du tout de sorcellerie, si l'on ne croyoit pas qu'il y en eust." But this being once believed, and the magistrate having set himself to punish an imaginary and impossible crime, the belief became stronger as the fires of persecution grew hotter, and each new holocaust only prepared fresh victims for the

Satan was chained in the bottom of hell, and consequently prevented from intermeddling with human affairs. The council had the good sense to be satisfied with this explanation; but the clergy of Holland, irritated at the indulgence shown to Bekker, overwhelmed it with reclamations, and forced it, by dint of clamour, to examine the affair more seriously. Bekker then demanded that the matter should be carried before the synod, and presented a new defence of his opinions; but the synod condemned the work, and deposed the author from his ministerial charge. This judgment was received with a sort of triumph by the clergy, and attacked by some of the author's friends in a clever tract, entitled, *Le Diable Triomphant, parlant sur le Mont Parnasse.* The synod, however, adhered to its sentence, and Bekker died of a pleurisy in 1698, without having been reinstated in his charge. On the occasion of his deposition, his enemies caused a medal to be struck, representing the devil dressed in clerical costume, and mounted upon an ass, with a sort of banner in his hand, emblematical of the triumph which the clergy had obtained in the synod. But this triumph was short-lived; for although the synod declared to a man in favour of the devil, the rational part of the world were ultimately convinced by the reasonings of the deposed minister; which soon began to gain ground, and contributed largely to emancipate the minds of men from the thraldom of a bloody and debasing superstition. Bekker, it seems, though a profound theologian and an able scholar, was a very ugly man, with bandy legs, and a nose and chin so prominent that they almost met; peculiarities which gave rise to the following epigram of Lamonnoye, prefixed to some of the French editions of *The World Bewitched:*—

Oui, par toi de Satan la puissance est brisée;
Mais tu n'as cependant pas encore assez fait;
Pour nous ôter du Diable entièrement l'idée,
Bekker, supprime ton portrait.

sacrifice. Dr Bekker concludes his remarkable work in these words:—"Si les souverains et les magistrats punissoient aussi exactement ceux qui accusent les autres de magie, qu'il y en a qui sont prestes à punir ceux qui sont accusés, lesquels ils jettent à la première délation dans les fers, et qu'ils donnassent la question seulement la moitié aussi forte aux délateurs, pour donner des preuves de leurs accusation, qu'ils la donnent à ceux-là pour confesser, je suis certain qu'ils n'auroient pas beaucoup besoin de bois pour les bruler. Car quoique dans le commencement ils eussent beaucoup à faire avant que cette nouvelle manière de plaider fust venue à leur connoissance, cela ne laisseroit pas de se passer bientost, lorsqu'ils verroient, qu'en accusant, ils se mettroient dans l'obligation de prouver ce qu'ils avanceroient, ou de subir la peine de la faute, en cas qu'ils ne peussent la prouver." Whoever takes the trouble to read the records of our own criminal procedure, and to observe the nature of the evidence upon which persons accused of witchcraft and sorcery were "fylit, convict, and brynt," will probably be convinced that these records would have been disgraced by few such atrocities had Dr Bekker's principle been adopted and acted upon. But a different form of practice was followed, of which it may with literal truth be said, *Siquidem accusâsse hic sufficit, quis insons habebitur?*[1]

Upon the whole, it is impossible not to regard the production of the Dutch divine as in many respects one of the most remarkable extant, considering the time when it appeared; nor are we aware of any similar instance of a writer who so far outstripped his age, and evinced so complete a superiority to its prejudices and superstitions. Bekker's work, indeed, had the misfortune to appear too soon; and of this he was early made sensible, by the torrent of abuse with which he was assailed, and the persecution he was called upon to undergo. What must have been the boldness and courage of that man who, in an age when the wildest fictions of demonology and witchcraft were implicitly, nay almost universally believed, commenced his attack on them by declaring, "C'est pour détruire cette vaine idole de la crédulité populaire que j'ai écrit mon livre: si le démon s'en fâche, qu'il emploie sa puissance pour m'en punir; s'il est Dieu, qu'il se défende lui-même, et qu'il s'en prenne à moi qui ait renversé ses autels!"

When Lucian ridiculed apparitions, and laughed at those who believed in them, he thought only of the lies, impostures, and absurdities which the ignorant and credulous had received as undoubted facts. All the passions exaggerate, and none more so than that of fear, the parent of superstition. Hence every thing seen through such a medium is beheld distorted, and out of all natural proportion. But, in cases of this description, it too frequently happens that the love of the marvellous comes in to finish the caricature which passion had commenced; and that imagination performs the double function of first imposing upon the seer himself, and afterwards contributing to enable him to impose still farther upon others. It is certain, indeed, that most if not all of the ghost stories which have been told are grossly exaggerated in almost every particular. Indeed, with the exception of Nicolai's truly philosophical narrative of the spectral illusions, which he beheld during a period of strong excitement produced by various misfortunes,[2] we scarcely know of a single case which does not bear on the face of it evident marks of embellishment and romance. Hence the difficulty of forming any theory of apparitions, to which, as matters stand, strong objections may not be taken, on the ground of its not embracing all, or even a majority, of the cases reported. We still want data upon which we can safely rely: and this want is to be ascribed mainly, if not solely, to the circumstance that every reporter was not a Nicolai; and that most of them have chosen rather to pander to the appetite for the marvellous than to tell their story simply and rationally. Lucian perceived this tendency of human nature, and unphilosophically ridiculed all apparitions as gross impositions on the credulity of the world; while the inquirers of the period to which we refer went to the opposite extreme, and, admitting every legend as authentic, racked their brains to account for what was in its own nature inexplicable upon any metaphysical theory. They never thought of cross-interrogating the witnesses before proceeding to consider the import of their testimony, or of endeavouring to test the credibility of the evidence before attempting to construct a theory out of it. They believed every thing without discrimination, and therefore could account for nothing. Thus Reginald Scot ridicules the paganism of the Church of Rome, yet comes to the conclusion that all her saints are as authentic devils as any in Pandemonium. Burton is scarcely more fortunate; and later inquirers, who finally gave up Satan and his invisible world altogether, landed in absurdities nearly as great as those they attempted to expose, though of course incomparably less mischievous.

But the progress of discovery and knowledge, independently of all theory, has cleared away many of the marvels which puzzled our ancestors. The devils, for example, which Benvenuto Cellini saw when he got into the conjurer's circle are now known to have been produced by a magic lantern; the Giant of the Broken, in the Hartz Mountains, has lost all his terrors since it was discovered that the spectre which had frightened men for ages is nothing more than the image of the individual who happens to be on the mountain-top at sun-rise reflected from the clouds beyond in gigantic proportions; and the Fata Morgana, as well as the Mirage, are now classed as pseudo-apparitions.

Of the more modern attempts to account for apparitions, the first which we shall notice is attributed to Meyer, and proceeds upon a particular theory respecting the origin of ideas, the conception of which appears to have

[1] One of the charges, it seems, against Dr Bekker, in the libel tried by the synod which ultimately deposed him, was his having attempted to banish all devils from the world. This absurd charge proceeded upon a complete misunderstanding of the whole gist and tenor of the work upon which it professes to be grounded. Dr Bekker does not deny the existence of the devil, as taught in Scripture, and is indeed most anxious to guard against such a construction being put upon his words, or such an inference deduced from his reasonings. The following passage, which is otherwise interesting, sets this in the clearest light:—"Ainsi la vérité de la Foy Chrétienne peut subsister, sans pourtant rien croire de la magie; ainsi moins l'on pense savoir ce que c'est que le diable, *à la reserve de ce que l'Ecriture nous en enseigne*, plus l'on peut connoître Dieu et Jesus Christ. Quand on ne connoit que Dieu, on en connoit assez; et toutes les connoissances qui sont hors de cet Etre Divin, ne sont que vanités et sottises." Scripture has declared that a knowledge of God is necessary to salvation; but it has nowhere said, so far as we remember, that, unless men know and believe in the devil, they will be damned. Dr Bekker, however, knew and believed all that the Scripture, rationally interpreted, warrants us to believe respecting the father of lies; and if his belief did not rise exactly to the pitch required by the demonologists of the Dutch synod, but, on the contrary, recoiled from their diabolical dogmas, it is precisely this inferiority of faith, conjoined with his manifest superiority of reason, which entitles him to the respect of all who can appreciate the honest boldness which enabled him to rise above the prejudices of his age, and to assail the abominations by which it was degraded and enslaved.

[2] Memoir on the Appearance of Spectres or Phantoms occasioned by Disease, with Psychological Remarks. Read by Nicolai to the Royal Society of Berlin on the 28th of February 1799. See a translation of this paper in *Nicolson's Journal*, vol. vi. p. 161. See also a good Memoir by Dr Alderson of Hull, in *Edinburgh Medical and Surgical Journal*, vol. vi.

been derived from the subtile images of Epicurus. These, the reader will remember, were held by the Epicureans to be spontaneously exhaled or given off by all bodies; and, when they entered the mind, or, we should rather say, were impressed on the attenuated atoms or corpuscles, of the material soul, were supposed to generate spectral illusions. Rejecting the notion of exhalation, however, M. Meyer adhered to the spirit of this philosophy; contending that all our ideas are material, and that they are transported from unknown sources to the storehouse of the memory, through the medium of the organs of sense. Hence it was conceived, that the nerves upon which sensations depend might not only be affected by external agents, but impressed by internal causes, and that the result of this impression would be hallucinations or illusions. Thus, rays of light impressing the optic nerves from without might cause the sensation of yellow, while corrupt humours, as those of jaundice for instance, by impressing the nerves from within, might produce a similar effect. Further, as ideas were held to be material, and might be treasured up by the memory, it was conceived that they might, through some unknown channel, find their way to the nerves, and impress them after the manner of internal causes influencing the mind. "I shall suppose," says M. Meyer, "that I have lost a parent whom I loved, and whom I have seen and spoken to an infinity of times. Having perceived him often, I have consequently preserved the material figure and perception of him in the brain; for it is very possible and reconcilable to appearances, that a material figure, like that of my deceased friend, may be preserved for a long time in my brain, even after his death. By some intimate yet unknown relation, therefore, which the figure may have to my body, it may touch the optic or acoustic nerves. In the very moment, then, that my nerves are affected in the same manner that they formerly were when I saw or listened to my living friend, I shall be necessarily induced to believe that I really see or hear him, as if he were present."[1] This has certainly the merit of being *teres atque rotundus;* but, in the first place, it proceeds upon the assumed materiality of ideas, which, besides being abandoned by all philosophers, is an assumption that is far from being self-evident, and can never be proved; secondly, M. Meyer is forced at every step to take for granted some new principle, in regard to the re-action of these material ideas on the nervous system, that equally requires, without admitting of, proof; lastly, he ascribes to his ideas the functions performed by the imagination, and thus infuses an ingredient of truth which gives a colour of plausibility to his theory.

Dr Ferriar's *Theory of Apparitions*, as he has been pleased to call his very entertaining collection of ghost stories, is a complete misnomer, inasmuch as the book really contains no theory at all. "It is a well-known law," says he at the outset, "that the impressions produced on some of the external senses, especially on the eye, are more durable than the application of the impressing cause." It certainly required no ghost to tell us this; yet it is all that Dr Ferriar has vouchsafed to give us of a theoretical kind; "and," as Dr Hibbert pertinently remarks, "the brevity with which it is given is in exact conformity with the abruptness of its dismissal; for, after being applied to explain one or two cases only of mental illusions, numerous other instances of the kind are related, but the theory is not honoured with any further notice." Still the book is valuable as a collection of cases establishing the existence of morbid impressions, without any sensible external agency, and also as showing the power which the imagination possesses under particular circumstances, of re-acting upon the organs of sense with an intensity sufficient to create a temporary belief in the reality of the objects, the impressions of which are thus renovated and vivified.[2]

The work of Dr Hibbert, modestly entitled *Sketches of the Philosophy of Apparitions,* is of a different description from that of Dr Ferriar. In it a theory is distinctly propounded, and followed up through a vast complexity of details, which the theory is employed to explain and reconcile; and if the author had carried his generalization a step further, and at the same time paid more attention to the logical arrangement of his topics, he would have left little to be supplied by any future writer on this curious branch of the philosophy of the human mind. As it is, however, the book is full of interesting matter, and, what is of still greater importance, it furnishes ample materials for extending and enlarging the view of the subject, which the author has, upon the whole, so satisfactorily developed. After a not very skilful sketch of the opinions, ancient and modern, which have been entertained respecting apparitions, Dr Hibbert proceeds, in the *first* place, to consider the morbid affections with which the production of phantasms is often connected; *2dly,* to show that the objects of spectral illusions are frequently suggested by the fantastic imagery of superstitious belief; *3dly,* to investigate the mental laws which give rise to spectral illusions; *4thly,* to notice the modifications which the intellectual faculty often undergoes during intense excitements of the mind; and, *lastly,* to state the comparative degrees of faintness, vividness, or intensity subsisting between sensations and ideas during their various excitements and depressions. And the general result at which he arrives, or, in other words, the law which connects and explains all the phenomena of apparitions, whether arising from morbid affections suggested by the fantastic imagery of superstition, or induced by certain states of the mind without any sensible extrinsic agency, is this, viz. "That apparitions are no-

[1] *Essay on Apparitions,* attributed to M. Meyer, professor in the university of Halle, 1748.

[2] An anecdote is told by this author, which serves to illustrate the incidental observation in the text:—"A gentleman was benighted, while travelling alone, in a remote part of the Highlands of Scotland, and was compelled to ask shelter for the evening at a small lonely hut. When he was to be conducted to his bed-room, the landlady observed, with mysterious reluctance, that he would find the window very secure. On examination, part of the wall appeared to have been broken down to enlarge the opening. After some inquiry, he was told that a pedlar, who had lodged in the same room a short time before, had committed suicide, and was found hanging behind the door in the morning. According to the superstition of the country, it was deemed improper to remove the body through the door of the house; and to convey it through the window was impossible, without removing part of the wall. Some hints were dropped that the room had been subsequently haunted by the poor man's spirit. My friend laid his arms, properly prepared against intrusion of any kind, by the bed-side, and retired to rest, not without some degree of apprehension. He was visited in a dream by a frightful apparition, and, awaking in agony, found himself sitting up in bed, with a pistol grasped in his right hand. On casting a fearful glance round the room, he discovered, by the moonlight, a corpse dressed in a shroud, reared erect against the wall, close to the window. With much difficulty he summoned up resolution to approach the dismal object, the features of which, and the minutest parts of its funeral apparel, he perceived distinctly. He passed one hand over it, felt nothing, and staggered back to the bed. After a long interval, and much reasoning with himself, he renewed his investigation, and at length discovered that *the object of his terror was produced by the moon-beams forming a long bright image through the broken window,* on which his fancy, *impressed by his dream,* had pictured, with mischievous accuracy, the lineaments of a body prepared for interment. Powerful associations of terror, in this instance, had excited the recollected images with uncommon force and effect

thing more than ideas, or the recollected images of the mind, which have been rendered as vivid as actual impressions;" a principle which, though somewhat incuriously expressed, makes, in our opinion, a very close approximation to the truth.

Dr Hibbert further conceives that the organs of sense are the actual medium through which past feelings are renovated; or, in other words, that when, from strong mental excitement, ideas have become as vivid as past impressions, or even more so, this intensity is induced by, or rather productive of, an absolute affection of those particular parts of the organic structure on which sensations depend; in the same way precisely as the salivary glands are known to be occasionally as much excited by the idea of some favourite food, as if the sapid body itself were actually present, stimulating the *papillæ* of the *fauces*. It would have been more simple and equally true if Dr Hibbert had said that the imagination, in some states, re-acts upon the organs of sense, and renovates past feelings or sensations, the natural antecedents of certain perceptions, with an intensity sufficient to create an illusion of reality; and this statement would have had the double advantage, of not only expressing, in a more generalized form, the important law of the human mind, which it is the object of all Dr Hibbert's investigations to evolve, but at the same time of excluding the particular views of physiology which are more or less mixed up with his metaphysical speculations. But the re-action in question may be either of a pleasurable kind or the reverse, according to the nature of the causes by which it is primarily produced; and as the mind can only exist in one state at an indivisible instant of time, it follows that when any agent, morbific or other, adds to the general vividness of our pleasurable feelings, those of an opposite or painful kind become proportionally less vivid, or rather are for the moment excluded; and, *vice versa*, the same law holds in regard to all our painful feelings, the increased intensity of which is necessarily accompanied with a corresponding abatement of those of an opposite kind. As the mind, however, passes from one state to another, or alternates between opposite states, with inconceivable rapidity, memory is sometimes apt to blend the recollected feelings of the one with those of the other, and thus to create a confusion in our conceptions of things which are in their own nature perfectly distinct. In some cases, where the nitrous oxide was administered, the patient, while under its influence, vibrated between perfect happiness and most consummate misery; but in the majority of instances the sensations produced were of a pleasurable description, to the exclusion of all those of an opposite kind; just as the sensations produced by an attack of the febrile miasma are almost invariably and exclusively those of the most acute pain. Hence the law above stated may be considered as a general one, when taken with the modifications proper to be applied to it. Lastly, Dr Hibbert has shown, that when mental feelings of any description attain a certain degree of vividness or intensity, muscular motions obey the impulse of the will, which is as much influenced by the re-acting and renovating power of imagination, as by any of our ordinary passions, appetites, or desires.

These principles, if we are not mistaken, go far to explain all the phenomena of dreams and apparitions; for the latter are merely waking dreams, and differ from the former in degree only, not in kind. In the case of Nicolai, which, as Dr Ferriar justly remarks, is one of the extreme instances of mental delusion which a man of strong judgment has ventured to report of himself, past impressions were renovated with the utmost accuracy and minuteness. The philosophical seer of Berlin beheld no "gorgons, hydras, and chimæras dire." The visions which he saw were neither terrible, ludicrous, nor repulsive; on the contrary, most of them were ordinary in their appearance, and some of them even agreeable. They were generally phantasms of his friends and acquaintance; or, in other words, exact copies of his past impressions and perceptions, so renovated and vivified as to create an illusion of reality, though for the most part oddly, if not grotesquely, put together. The story told so well by Dr Ferriar of the vision seen by the benighted gentleman who took up his quarters in the lonely Highland hut, is explicable on precisely the same principle; for his imagination, excited by his dream, pictured the corpse of the self-murdered pedlar behind the door by renovating and vivifying the mental images produced by the recital of the circumstances previously given to the traveller. In the cases of disease or superstition, again, the exciting causes are different, and the illusions generated consequently vary; but, in every instance where we can get at the circumstances, it will be found that these illusions or phantasms are merely vivid renovations of mental impressions previously received, and that, although the grouping may be fantastical, the ordinary laws of association are never transgressed.

Dr Brewster has remarked, as a physical fact, that "when the eye is not exposed to the impressions of external objects, or when it is insensible to these objects in consequence of being engrossed with its own operations, any object of mental contemplation, which has either been called up by the memory or created by the imagination, *will be seen as distinctly as if it had been formed from the vision of a real object.* In examining these mental impressions," he adds, "I have found that they follow the motions of the eye-ball exactly like the spectral impressions of luminous objects, and that they resemble them also in their apparent immobility when the eye-ball is displaced by an external force. If this result shall be found generally true by others, it will follow that the objects of mental contemplation *may be seen as distinctly as external objects*, and will occupy *the same local position in the axis of vision* as if they had been formed by the agency of light."[1] This goes to the very root of the theory of apparitions; all the phenomena of which seem to depend upon the relative intensities of the two classes of impressions, and upon the manner of their accidental combination. In perfect health, the mind not only possesses a control over its powers, but the impressions of external objects alone occupy its attention, and the play of imagination is consequently checked, except in sleep, when its operations are relatively more feeble and faint. But in the unhealthy state of the mind, when its attention is partly withdrawn from the contemplation of external objects, the impressions of its own creation, or rather reproduction, will either overpower or combine themselves with the impressions of external objects, and thus generate illusions which in the one case appear alone, while in the other they are seen projected among those external objects to which the eye-ball is directed, in the manner explained by Dr Brewster. We may add, that the same reasoning which applies to the impressions derived from the sense of sight, is equally applicable to those received

[1] See in the *Edinburgh Journal of Science*, conducted by Dr Brewster, a paper by the editor, entitled "Observations on the Vision of Impressions on the Retina, in reference to certain supposed Discoveries respecting Visions announced by Mr Charles Bell." Vol. ii. p. 1.

through the medium of any other sense,—as the ear, for instance, an organ which ministers abundantly to the production of spectral illusions.

Again, with regard to those illusions, the objects of which are, according to this theory, suggested by the imagery of superstition, it is obvious that a belief in such imagery is calculated, in an ignorant and credulous age, to make a strong impression on the mind, and to imbue it deeply with all the peculiarities of the prevailing creed. In point of fact, there is nothing which men know so thoroughly, or remember so minutely, as superstitious legends, when this unearthly lore forms the subject of unquestioned and unquestionable belief. But all such impressions are more or less productive of and accompanied with fear; and hence when, from accidental circumstances, this passion happens to be excited to any degree of intensity, it not only withdraws the attention of the mind from the contemplation of external objects, but at the same time stimulates the imagination; which, again, reacts through the senses, vivifying mental images alone, or perhaps intermingling them, in fantastical combinations, with the impressions derived from external objects, and thus creating those spectral illusions which dreamers and seers in all ages have mistaken for realities. If the force of imagination alone can in some instances, without any sensible extrinsic agency, generate unreal mockeries and phantasms, much more must it do so when excited by a belief in supernatural agency, reinforced by fear, the most powerful of all the passions. "What brighter colours the fears of superstition give to the dim objects perceived in twilight, the inhabitants of the village," says Dr Thomas Brown, "who have to pass the churchyard at any late hour, and the little students of ballad-lore, who have carried with them, from the nursery, many tales which they almost tremble to remember, know well. And in the second sight[1] of this northern part of the island, there can be no doubt, that the objects which the seers conceive themselves to behold, are truly more vivid as conceptions, than, but for the superstitious and melancholy character of the natives, which harmonize with the objects of this foresight, they would have been; and that it is in consequence of this brightening effect of the emotion, as concurring with the dim and shadowy objects which the vapoury atmosphere of our lakes and valleys presents, that *fancy, relatively to the individual, becomes a temporary reality*. The gifted eye, which has once believed itself favoured with such a view of the future, will, of course, ever after have a quicker foresight, and more frequent revelations; its own wilder emotion communicating still more vivid forms and colours to the objects which it dimly perceives." In the case of such visions, however, there is often more of delusion in the seer, than of illusion in the phantasms which his "gifted eye" is supposed to have beheld; and hence the difficulty, as we have already remarked, or perhaps it would be more correct to say the impossibility, of explaining upon any one theory all the phenomena, as these have been detailed. But although it is inconsistent with the object of this article to diverge into illustrations in detail, we may be permitted to observe that all the narratives of spectral illusions which can be relied upon as deserving of credit, are perfectly explicable upon the principles here briefly but we trust intelligibly unfolded.

Having said thus much in reference to the theory of apparitions, it will not be necessary to enter at any length into that part of Sir Walter Scott's work on demonology and witchcraft[2] which relates to the present subject. Sir Walter has indeed attempted to sound the very depths of the philosophy of spectral illusion, and to account for their phenomena on known or admitted principles; but, with all possible respect and deference for this gifted writer, it may be doubted whether his line has reached the bottom, or afforded any just measure of its profundity. He has narrated, with a skill and effect peculiar to himself, a number of very striking cases,[3] and has connected these by a variety of observations, some of them not less remarkable for the

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[1] Most of the stories of second-sight told by the Highlanders seem arrant fabrications; and although we are by no means inclined to doubt the possibility of such illusions, any more than to question the fact, that they have sometimes accidentally coincided in point of time with events which seemed to give some confirmation to the belief in deuteroscopy, yet there is so much absurdity and imposture in nearly all the narratives of this kind which we have read, that we consider them utterly unworthy of serious consideration. The honest fellow who proposed to sell the secret for a pound of tobacco, knew more of the mysteries of second-sight than some grave philosophers. Dr John Macculloch has the following very pertinent remarks on the subject:—"To have circumnavigated the Western Isles without even mentioning the second-sight, would be unpardonable. No inhabitant of St Kilda pretends to have been forewarned of our arrival; ceasing to be believed, it has ceased to exist. It is indifferent whether the propagators of an imposture, or of a piece of supernatural philosophy, be punished or rewarded. In either case the public attention is directed towards the agent; whether by the burning of the witch, or by the flattering distinction which attended the Highland seer. When witches were no longer burned, witchcraft disappeared. Since the second-sight has been limited to a doting old man, or a hypochondriacal tailor, it has been a subject for ridicule; and in matters of this nature ridicule is death." (*Description of the Western Isles*, by John Macculloch, M. D. vol. ii. p. 32.) While the world believed in the second-sight and in witchcraft, there never failed to be seers and witches. The supposed possession of these faculties insured notoriety, flattered vanity, conferred power, and afforded the means of gratifying malice: And what will not men and women do to attain distinctions and advantages like these? The vain will covet them, the ambitious will grasp at them, the malicious, if otherwise helpless and spited at the world, will run all risks, both here and hereafter, to secure them. Hence the enormous impostures of witchcraft, and hence also delusions as hideous as the knavery was gross and revolting. This is the true key to the solution of a vast number of cases which, it has been supposed, we can neither believe, account for, nor refute. But the misfortune is, that most of those who have written on the subject have had more faith than philosophy, and more fancy than faith, in consequence of which they have jumbled truth and falsehood together in such wild confusion, that all the alchemy of logic is insufficient to resolve the compound into its constituent elements, and separate the one from the other.

[2] *Letters on Demonology and Witchcraft*, addressed to J. G. Lockhart, Esq. By Sir Walter Scott, Bart.

[3] The following is one of the *most* striking, and although the narrative be long, it will be found exceedingly interesting:—"A second, and equally remarkable instance, was communicated to the author by the medical man under whose observation it fell, but who was, of course, desirous to keep private the name of the hero of so singular a history. Of the friend by whom the facts were attested, I can only say, that if I found myself at liberty to name him, the rank which he holds in his profession, as well as his attainments in science and philosophy, form an undisputed claim to the most implicit credit.

"It was the fortune of this gentleman to be called in to attend the illness of a person now long deceased, who in his lifetime stood, as I understand, high in a particular department of the law, which often placed the property of others at his discretion and control, and whose conduct, therefore, being open to public observation, he had for many years borne the character of a man of unusual steadiness, good sense, and integrity. He was, at the time of my friend's visits, confined principally to his sick-room, sometimes to bed, yet occasionally attending to business, and exerting his mind, apparently with all its usual strength and energy, to the conduct of important affairs intrusted to him; nor did there, to a superficial observer, appear any thing in his conduct, while so engaged, that could argue vacillation of intellect or depression of mind. His outward symptoms of malady argued no acute or alarming disease. But slowness of pulse, absence of appetite, difficulty of digestion, and constant depression of spirits, seemed to draw their origin from

 acuteness they display, than for the very great felicity with which they are expressed. But even with Dr Hibbert's work as a guide, and all the collateral lights which have been thrown upon the subject by the researches of

some hidden cause, which the patient was determined to conceal. The deep gloom of the unfortunate gentleman—the embarrassment, which he could not conceal from his friendly physician—the briefness and obvious constraint with which he answered the interrogations of his medical adviser—induced my friend to take other methods for prosecuting his enquiries. He applied to the sufferer's family, to learn, if possible, the source of that secret grief which was gnawing the heart and sucking the life-blood of his unfortunate patient. The persons applied to, after conversing together previously, denied all knowledge of any cause for the burden which obviously affected their relative. So far as they knew—and they thought they could hardly be deceived—his worldly affairs were prosperous; no family loss had occurred which could be followed with such persevering distress; no entanglements of affection could be supposed to apply to his age, and no sensation of severe remorse could be consistent with his character. The medical gentleman had finally recourse to serious argument with the invalid himself, and urged to him the folly of devoting himself to a lingering and melancholy death, rather than tell the subject of affliction which was thus wasting him. He specially pressed upon him the injury which he was doing to his own character, by suffering it to be inferred that the secret cause of his dejection, and its consequences, was something too scandalous or flagitious to be made known, bequeathing in this manner to his family a suspected and dishonoured name, and leaving a memory with which might be associated the idea of guilt, which the criminal had died without confessing. The patient, more moved by this species of appeal than by any which had yet been urged, expressed his desire to speak out frankly to Dr ——. Every one else was removed, and the door of the sick-room made secure, when he began his confession in the following manner:—

"'You cannot, my dear friend, be more conscious than I, that I am in the course of dying under the oppression of the fatal disease which consumes my vital powers; but neither can you understand the nature of my complaint, and the manner in which it acts upon me; nor, if you did, I fear, could your zeal and skill avail to rid me of it.'—'It is possible,' said the physician, 'that my skill may not equal my wish of serving you; yet medical science has many resources, of which those unacquainted with its powers never can form an estimate. But until you plainly tell me your symptoms of complaint, it is impossible for either of us to say what may or may not be in my power, or within that of medicine.'—'I may answer you,' replied the patient, 'that my case is not a singular one, since we read of it in the famous novel of Le Sage. You remember, doubtless, the disease of which the Duke d'Olivarez is there stated to have died?'—'Of the idea,' answered the medical gentleman, 'that he was haunted by an apparition, to the actual existence of which he gave no credit, but died, nevertheless, because he was overcome and heart-broken by its imaginary presence.'—'I, my dearest Doctor,' said the sick man, 'am in that very case; and so painful and abhorrent is the presence of the persecuting vision, that my reason is totally inadequate to combat the effects of my morbid imagination, and I am sensible I am dying, a wasted victim to an imaginary disease.' The medical gentleman listened with anxiety to his patient's statement, and for the present judiciously avoiding any contradiction of the sick man's preconceived fancy, contented himself with more minute enquiry into the nature of the apparition with which he conceived himself haunted, and into the history of the mode by which so singular a disease had made itself master of his imagination, secured, as it seemed, by strong powers of the understanding, against an attack so irregular. The sick person replied by stating, that its advances were gradual, and at first not of a terrible or even disagreeable character. To illustrate this, he gave the following account of the progress of his disease.

"'My visions,' he said, 'commenced two or three years since, when I found myself from time to time embarrassed by the presence of a large cat, which came and disappeared I could not exactly tell how, till the truth was finally forced upon me, and I was compelled to regard it as no domestic household cat, but as a bubble of the elements, which had no existence save in my deranged visual organs or depraved imagination. Still I had not that positive objection to the animal entertained by a late gallant Highland chieftain, who has been seen to change to all the colours of his own plaid if a cat by accident happened to be in the room with him, even though he did not see it. On the contrary, I am rather a friend to cats, and endured with so much equanimity the presence of my imaginary attendant, that it had become almost indifferent to me; when within the course of a few months it gave place to, or was succeeded by, a spectre of a more important sort, or which at least had a more imposing appearance. This was no other than the apparition of a gentleman-usher, dressed as if to wait upon a lord-lieutenant of Ireland, a lord high commissioner of the kirk, or any other who bears on his brow the rank and stamp of delegated sovereignty.

"'This personage, arrayed in a court dress, with bag and sword, tamboured waistcoat, and *chapeau-bras*, glided beside me like the ghost of Beau Nash; and, whether in my own house or in another, ascended the stairs before me, as if to announce me in the drawing-room; and at some times appeared to mingle with the company, though it was sufficiently evident that they were not aware of his presence, and that I alone was sensible of the visionary honours which this imaginary being seemed desirous to render me. This freak of the fancy did not produce much impression on me, though it led me to entertain doubts on the nature of my disorder, and alarm for the effect it might produce upon my intellects. But that modification of my disease also had its appointed duration. After a few months the phantom of the gentleman-usher was seen no more, but was succeeded by one horrible to the sight and distressing to the imagination, being no other than the image of death itself—the apparition of a *skeleton*. Alone or in company,' said the unfortunate invalid, 'the presence of this last phantom never quits me. I in vain tell myself a hundred times over that it is no reality, but merely an image summoned up by the morbid acuteness of my own excited imagination and deranged organs of sight. But what avail such reflections, while the emblem at once and presage of mortality is before my eyes, and while I feel myself, though in fancy only, the companion of a phantom representing a ghastly inhabitant of the grave, even while I yet breathe on the earth? Science, philosophy, even religion, has no cure for such a disorder; and I feel too surely that I shall die the victim to so melancholy a disease, although I have no belief whatever in the reality of the phantom which it places before me.'

"The physician was distressed to perceive, from these details, how strongly this visionary apparition was fixed in the imagination of his patient. He ingeniously urged the sick man, who was then in bed, with questions concerning the circumstances of the phantom's appearance, trusting he might lead him, as a sensible man, into such contradictions and inconsistencies as might bring his common sense, which seemed to be unimpaired, so strongly into the field, as might combat successfully the fantastic disorder which produced such fatal effects. 'This skeleton, then,' said the Doctor, 'seems to you to be always present to your eyes?'—'It is my fate, unhappily,' answered the invalid, 'always to see it.'—'Then I understand,' continued the physician, 'it is now present to your imagination?'—'To my imagination it certainly is so,' replied the sick man.—'And in what part of the chamber do you now conceive the apparition to appear?' the physician enquired. 'Immediately at the foot of my bed; when the curtains are left a little open,' answered the invalid, 'the skeleton, to my thinking, is placed between them, and fills the vacant space.'—'You say you are sensible of the delusion,' said his friend; 'have you firmness to convince yourself of the truth of this? Can you take courage enough to rise and place yourself in the spot so seeming to be occupied, and convince yourself of the illusion?' The poor man sighed, and shook his head negatively. 'Well,' said the Doctor, 'we will try the experiment otherwise.' Accordingly, he rose from his chair by the bedside, and placing himself between the two half-drawn curtains at the foot of the bed, indicated as the place occupied by the apparition, asked if the spectre was still visible? 'Not entirely so,' replied the patient, 'because your person is betwixt him and me; but I observe his skull peering above your shoulder.'

"It is alleged the man of science started on the instant, despite philosophy, on receiving an answer ascertaining, with such minuteness, that the ideal spectre was close to his own person. He resorted to other means of investigation and cure, but with equally indifferent success. The patient sunk into deeper and deeper dejection, and died in the same distress of mind in which he had spent the latter months of his life; and his case remains a melancholy instance of the power of imagination to kill the body, even when its fantastic terrors cannot overcome the intellect, of the unfortunate persons who suffer under them. The patient, in the present case, sunk under his malady; and the circumstances of his singular disorder remaining concealed, he did not, by his death and last illness, lose any of the well-merited reputation for prudence and sagacity which had attended him during the whole course of his life."

Dr Ferriar, Sir David Brewster, &c., Sir Walter has failed to reach any general principle applicable to a given class of cases. The consequence is, that, although his observations are almost always valuable, and often involve the very law which connects and explains the phenomena of spectral illusion, he constantly stops short on the verge of the discovery, and is therefore under the necessity of seeking a new explanation of each successive case, which is, for the most part, considered separately and without reference to or comparison with others. On several occasions, indeed, he attempts to generalize, and makes very close approximations to the truth; but, like those tuneless persons who sometimes essay good-naturedly to sing, and stumble about the outskirts of an air, without ever being able to hit it exactly, Sir Walter frequently comes so very near the point he aims at, that we are surprised how he should miss it.

This is singularly exemplified in the following observations, which, with reference to the view we have now taken, are exceedingly important:—"Enthusiastic feelings of an impressive and solemn nature," says Sir Walter, "occur both in private and public life, which seem to add ocular testimony to an intercourse betwixt earth and the world beyond it. For example, the son who has been lately deprived of his father feels a sudden crisis approach, in which he is anxious to have recourse to his sagacious advice—or a bereaved husband earnestly desires again to behold the form of which the grave has deprived him for ever—or, to use a darker yet very common instance, the wretched man who has dipped his hand in his fellow-creature's blood, is haunted by the apprehension that the phantom of the slain stands by the bedside of his murderer. In all, or any of these cases, who shall doubt that *imagination*, favoured by circumstances, *has power to summon up to the organ of sight spectres which only exist in the mind of those by whom their apparition seems to be witnessed?* If we add, that such a vision may take place in the course of one of those lively dreams in which the patient, except in respect to the single subject of *one* strong impression, is or seems sensible of the real particulars of the scene around him, a state of slumber which often occurs—if he is so far conscious, for example, as to know that he is lying on his own bed, and surrounded by his own familiar furniture, at the time when the supposed apparition is manifested, it becomes almost in vain to argue with the visionary against the reality of his dream, since the spectre, though itself purely fanciful, *is inserted* amidst so many circumstances which he feels must be true beyond the reach of doubt or question. That which is undeniably certain becomes in a manner a warrant for the reality of the appearance to which doubt would have been otherwise attached. And if any event, such as the death of the person dreamt of, *chances to take place*, so as to correspond with the nature and the time of the apparition, *the coincidence*, though one which must be frequent, since our dreams usually refer to the accomplishment of that which haunts our minds when awake, and often presage the most probable events, seems perfect, and the chain of circumstances touching the evidence may not unreasonably be considered as complete."

Now, it must be obvious to every one, that the true theory of apparitions is involved in these observations, though not unfolded in such a manner as to render it available for the explanation of spectral illusions. The author distinctly indicates, in the first place, the power of imagination, when excited, "to summon up to the organ of sight spectres which only exist in the mind of those by whom their apparition seems to be witnessed," or, in other words, to reproduce past impressions through the medium of the senses; and, secondly, in certain kinds of *dreams*, he recognises the principle, which Sir D. Brewster has shown to hold good in our waking hours, that "the objects of mental contemplation may be seen as distinctly as external objects, and will occupy the same local position in the axis of vision, as if they had been formed by the agency of light;" while their being "inserted" amidst so many objects in regard to which there is no deception, will at the same time contribute to strengthen the illusion of reality, and to render the visionary inaccessible to any arguments tending to call it in question. But no use whatever is made of these important principles; which, so far from being pushed to their consequences, and thus disencumbered of the limitations which the author has assigned to them, are stated apparently for no other reason than that they may be straightway cast aside and forgotten.

Another example may be given of this unavailing approximation to the truth, on a most important branch of the subject. That disordered or excited state of the imagination arising from morbific causes, in which it re-acts upon the organs of sense, and generates spectral illusions, "is not," he thinks, "properly insanity, although it is somewhat allied to that most horrible of maladies, and may, in many constitutions, be the means of bringing it on, and although such hallucinations are proper to both." The difference he conceives to be, that "in cases of insanity, the mind of the patient is principally affected, while the senses or organic system offer in vain to the lunatic their decided testimony against the phantasy of a diseased imagination." There is some confusion here, both in conception and expression; but still the author is correct in his general idea, however vaguely indicated, that the difference he alludes to is one of degree rather than of kind. A few observations will, we think, make this abundantly evident, and at the same time show in how remarkable a manner the phenomena of insanity, viewed in reference to the subject before us, illustrate that reflective or renovating power of the imagination to which alone we ascribe the production of phantasms and spectres.

The history of this malady (says Pinel) claims alliance with all the errors and delusions of superstitious credulity —with those of witchcraft, demoniacal possession, oracles, divinations, and spectral illusions; and hence he considers it as eminently deserving of attention, on the part of the mental, as well as on that of the medical philosopher who may be called upon practically to minister consolation and relief to minds diseased. Insanity, considered generally, is merely the excess of that state or of those states of the mind during which hallucinations are produced; and this excess, when prolonged beyond a certain limit, terminates in fatuity, or the complete exhaustion and paralysis of the mental powers, just as bodily exertion, when urged beyond a certain pitch (varying, however, in each individual), terminates in the suspension of all physical energy, and ultimately in death. In both cases nature has provided a restorative power, which, up to a definitive point, can repair the injury produced by excited action, and enable the mind and body to recover their wonted tone and health; but if the excitation continue, or be pushed beyond this limit, the restorative efficacy is destroyed, and neither can ever regain their former condition. It is this excess alone which, in the case of mind, constitutes insanity. It is the unnatural continuance or prolongation of excited action which ultimately overwhelms the whole mental powers; not even excepting the imagination itself, the very instrument, if we may so express it, by which this melancholy ruin is accomplished. Hence it is commonly observed that persons endowed with the greatest susceptibility of mental excitement, with the warmest passions, the most active imaginations, and the most acute sensibilities, evince the strongest pre-

Apparitions. disposition to insanity; and as this is the temperament that usually accompanies genius, every one can easily appreciate the truth of the observation which a celebrated poet has consecrated in his numbers, that great wit is nearly allied to madness, and that "thin partitions do the bounds divide" which separate the one from the other. But this predisposing temperament, of which genius is a natural product, and insanity the excess or diseased state, is also that which renders men peculiarly susceptible of superstitious impressions, and upon which these, when once received into the mind, and treasured up in the memory, are likely, through the medium of the imagination, to re-act with the greatest force, and thus to give a sort of reflex impulse to the temperament which predisposes towards their reception. Need we wonder, then, to find the imagery of superstition so frequently blended and mixed up with the wild delusions of insanity, or the one acting upon and aggravating all the symptoms of the other? Need we wonder that in a great variety of instances superstition should become the exciting cause of insanity, or that the visions of insanity should, in their turn, form new objects of superstition?

In all cases of mental excitement, howsoever produced, the results may vary in proportion to the relative intensity of the excited action; but on a close examination it will be found that the difference observable amongst them is a difference of degree only, not of kind. "From recalling images by an act of the memory," says Dr Ferriar, "the transition is direct to beholding spectral objects which have been floating in the imagination;" and he adds that he has frequently, in the course of his professional practice, conversed with persons who imagined they saw demons, and heard them speak; a species of delusion which, he thinks, admits of many gradations and distinctions exclusive of actual insanity. Sir Walter Scott also mentions the case of a patient similarly affected, who, being troubled with a diurnal vision of an unsightly hag, consulted the late Dr Gregory on the subject of this visitation, but, as appears from the narrative, without deriving any material benefit from the skill of that eminent and learned physician. As the spectre was very regular in its appearance, and always visited the patient at a stated hour, the doctor, on one occasion, exerted all his powers of conversation, which were very great, to engage the mind of this individual, and if possible beguile him into a forgetfulness of time, that the awful hour might pass unobserved—but, as it turned out, without effect; for scarcely had the clock struck the hour, when the patient screamed out that he beheld the apparition. Ordinary impressions, indeed, are never sufficient to control such as are produced by an imagination excited as this man's must have been. Hence, finding his expedient vain, Dr Gregory had recourse to his usual remedy of blood-letting, in order to relieve the plethoric or apoplectic affection under which he concluded that the patient must be labouring; but whether this antiphlogistic treatment had the effect of dismissing the phantom hag who had previously repeated her visits so regularly, Sir Walter has not informed us. Delusions of this sort, as Dr Ferriar observes, certainly admit of gradations short of actual insanity; but the difference, as we have already remarked, is one of degree only, not of kind; for, in all such cases, a little additional intensity of excitement is only wanting to deprive the mind of that power over its impressions generally which it has already lost over one set, and thus to overwhelm it at once under a hideous mass of morbid hallucinations. The same observation is applicable to the partial illusions generated by hysteria, hypochondria, febrile affections, inflammations of the brain, *delirium tremens*, and other diseases which exert a disturbing influence over the nervous system, especially that part of it more immediately connected with sensation. The exciting causes may vary, and the particular illusions created may partake of this variation; yet it will be found that, the excitement once produced, the resulting phenomena observe invariably the same law, and that according as the degree of that excitement is greater or less, so will the morbid affection of the mind either amount to actual insanity, or fall short of it by some gradations. The true theory of apparitions, therefore, is essentially the same with that of insanity; nor, in determining the general principle which connects the one class of phenomena, can we fail, if we pursue the proper course of investigation, to ascertain that which regulates and consequently explains the other.[1]

These observations, as the reader must have already perceived, apply only to that part of Sir Walter Scott's work which relates to apparitions, and which, in fact, is greatly inferior in interest as well as importance to the masterly exposition he has given of the various systems of magic and demonology which have prevailed at different times and in different countries. Here he is evidently quite at home; and as his treasures of ghostly lore are unbounded, his judicious observations are continually illustrated by the most apposite and striking narratives, frequently derived from sources which are not generally accessible. His remarks on the denunciation against witches contained in the Old Testament, as well as on the particular case of the sorceress of Endor, consulted by Saul, are exceedingly interesting; and we think the distinction he has drawn between Jewish witchcraft, which was connected with the abominations of idolatry, and that of modern times, which was the joint product of ignorance, credulity, fear, persecution, and imposture, perfectly sound. That the witch of Endor was a mere fortune-teller, to whom the unfortunate king of Israel had recourse in his despair, is beyond all question or doubt; and the only difficulty is to explain how it was so ordained that the spirit of the prophet Samuel should arise amidst the incantations of an impostor, and thus lend a

[1] The activity which the soul frequently displays during sleep, or, in other words, the phenomena of dreams, engaged the attention of metaphysicians at an early period, and gave rise to numerous learned and ingenious speculations, an exquisite summary of which, accompanied with many truly refined and subtile observations of his own, the reader will find in the chapter where Mr Dugald Stewart treats of this subject in his *Elements of the Philosophy of the Human Mind.* "Dreams," says Mr Addison, "look like the relaxations and amusements of the soul when she is disencumbered of her machine; her sports and recreations when she has laid her charge asleep. The soul is clogged and retarded in her operations when she acts in conjunction with a companion that is so heavy and unwieldy in its motions; but in dreams she converses with numberless beings of her own creation, and is transported into ten thousand scenes of her own raising. She is herself the theatre, the actor, and the beholder." This is finely said, and not more beautiful than true. But the reader will not fail to observe, that as Mr Addison's description, if somewhat heightened in its colouring and distorted in its features, would apply to insanity as well as to dreams, so the state of the soul which produces the one would, if highly excited, exhibit all the characteristic phenomena of the other. Dreams, indeed, are but faint adumbrations of that vivid phantasmagoria which madness presents to the eye of the mind, and which is also accompanied with an increased intensity in all the feelings and emotions of the soul, whether connected with the predominant hallucination, or otherwise. Hence Pinel has remarked, that, even during the intervals of comparative calmness and reason, he has nowhere met, except in romance, with fonder husbands, more affectionate parents, more impassioned lovers, or purer and more exalted patriots, than in an asylum for lunatics.

sort of countenance to the belief in magical charms and divinations, which was already but too generally and deeply rooted in the minds of the Israelites. This, however, is not the place to enter into the discussion of matters which properly fall to be treated of under different heads, and which involve principles totally different from those which are applicable to the case of apparitions alone. (J. B—E.)

APPARITOR, among the *Romans*, a general term to comprehend all attendants of judges and magistrates appointed to receive and execute their orders. *Apparitor*, in England, is a messenger that serves the process of a spiritual court, or a beadle in a university who carries the mace.

APPEAL, in its usual modern sense, is the act by which a decision is brought for review from an inferior to a superior court. In Roman jurisprudence it was used in this and in other significations; it was sometimes equivalent to prosecution, or the calling up of an accused person before a tribunal, where the accuser appealed to the protection of the magistrate against injustice or oppression. The derivation from the word *appello*, naturally shows its earliest meaning to have been an urgent outcry or prayer against injustice. Hence it inferred a superior power capable of protecting against petty tyranny. In its meaning of seeking a higher tribunal for recourse against a lower, it does not seem to have been a characteristic of the Republic, where the magistrate was generally supreme within his sphere, and those who felt themselves outraged by injustice, threw themselves on popular protection by *provocatio*, instead of looking to redress from a higher official authority. The Empire, however, introduced grades of jurisdiction, and the ultimate remedy was an appeal to the emperor; thus Paul, when brought before Festus, appealed unto Cæsar. It must be understood that the appeal was actually dealt with by a supreme judge representing the emperor, not by the emperor in person. In the *corpus juris*, the appeal to the emperor is called indiscriminately *appellatio* and *provocatio*. A considerable portion of the 49th book of the Pandects is devoted to appeals, but little of the practical operation of the system is to be derived from the propositions there brought together.

The ecclesiastical hierarchy, and the gradations of the feudal system, naturally afforded scope in the middle ages for appeals from the lower to the higher authority. In matters ecclesiastical, including those matrimonial testamentary and other departments which the church ever tried to bring within the operation of the canon law, there were various grades of appeal, ending with the Pope. The European princes in general struggled against this assumption of authority by the court of Rome, and it was the source of many contests between the ecclesiastical and the regal power.

It became customary for ambitious sovereigns to encourage appeals from the courts of the crown vassals, to themselves as represented by the supreme judges, and Charlemagne usually enjoys the credit of having set the example of this system of centralization, by establishing *missi dominici*. The great vassals, however, sought recourse against the decisions of the royal courts in their own order embodied as the great council or parliament of the nation, and hence arose the appeal to the House of Lords as the court of last resort.

When the progress of civilization and the art of self-government renders judges no longer amenable to the charge of tyranny or fraud, an appellate system changes its character and objects. It in some measure certainly tends to preserve that judicial integrity which renders it unnecessary as the immediate refuge of the persecuted suitor. But its ostensible object is the preservation of uniformity in the law. The attainment of this object renders it unfortunately necessary in such a country as ours, that no tribunal shall give, in the first instance, in any important question, a decision which is not open to appeal. The process has the double advantage, that it has a tendency to bring every legal difficulty ultimately through one tribunal, where a uniformity of principle may be expected in the application of the law, and, at the same time, stimulates the exertions of the subordinate judge, who, knowing that his proceedings will be revised, is careful to bring them as close as he can to those uniform principles of law which he knows that the court of appeal will apply. To accomplish this function of an appellate system, it is right that the investigation of the question at issue should have been exhausted in the inferior court, and that the court of appeal should have nothing before it which has not been there considered; for if the inferior court decide on one representation of circumstances, and the court of appeal on another, the public will lose the advantage of having the principle which was applied in the inferior reversed or affirmed in the superior tribunal.

The House of Lords is a court of appeal from all the chief civil and criminal courts in the United Kingdom, except the High Court of Justiciary in Scotland. It is only, however, in questions coming from the Equity Courts and the Court of Session in Scotland, that the term appeal is employed. The references from the common law courts have the name writ of error, which more characteristically expresses the function of a court of last resort from tribunals not suspected of partiality or tyranny, as being less an appeal from injustice than an application to correct the law administered by the court below. The origin of the appellate jurisdiction of the House of Lords was undoubtedly of that partly feudal and partly popular character already alluded to, which made the suitor seek justice from the high court of Parliament, when it was refused in the baronial court or even by the king's judges. Hence the lords exercised the mixed function of jurymen and judges, and, as in judgments on impeachment, the house might be influenced by private or party considerations, debating and dividing on the question before them. A revolution was silently accomplished, however, by which the function of reviewing the decisions of the courts fell entirely to the lawyers raised to the peerage, or to other judges brought in to give their aid; and the unprofessional lords now only attend to give the sanction of a quorum to the proceedings. The letters and memoirs, so late as Queen Anne's reign, show that party or personal influence and persuasion were employed to procure votes on appeals, as they have in later times on railway or other local bills. The last instance probably in which a strong division of opinion was manifested among the unprofessional lords was the celebrated Douglas cause in 1769, when the house was addressed by the Dukes of Newcastle and Bedford, but were led by the authoritative opinion of Lord Mansfield on the effect of the evidence; an opinion which, being treated rather as that of a political partisan than of a judge, was sharply commented on in a work of great talent written by Mr James Stuart, who had a deep personal interest in the cause. The case of O'Connell and others, brought up on writ of error from the Queen's Bench in Ireland, in 1844, may be said to have finally established the precedent, that the judgments of the House of Lords are to be given solely by the law lords. On that occasion there was a difference of opinion among the law lords themselves. The judgment of the majority was strongly against the political feeling of the government and of the peers as a body, while the law lords who carried the decision had been appointed by previous governments, opposed in politics to the existing cabinet. But all these temptations to a party vote by the unprofessional members were resisted.

Appeal.

The large proportional amount of the judicial work in the House of Lords caused by appeals from Scotland has been often noticed. It proceeds from two causes. In England there is a virtual appeal by writ of error from any one of the common law courts to the other two, not exemplified in Scotland. But there have always appeared to the disappointed Scottish litigant chances in his favour from his appeal lying to English judges against the Scottish judges who have decided against him. It has been said that such expectations have not always been disappointed, and that the English law lord has sometimes been unable so entirely to divest himself of professional prejudices, as to administer the law of Scotland without being biased by that of England. If the changes thus sometimes made in Scots law by such high authority have been improvements, yet it may justly be said that they should have been imparted by statute, not by judicial decisions.

Of old, in Scotland, there was something anomalous in an appeal to Parliament, as the Court of Session was, in its original constitution a committee of Parliament, for the performance of its judicial functions. In the reign of Charles II., however, the courts grew so intolerably corrupt that a determined effort was made to have their judgments overturned by an appeal, which was strictly of the old character of a cry for protection against flagrant injustice. It was called a "protest for remeid of law," and was inserted as one of the national claims in the petition of right at the Revolution. There was no allusion to an appeal system in the Treaty of Union; but the House of Lords, when appealed to against the judgments of the Court of Session, acted without hesitation. Many attempts were made, but without effect, to carry appeals from the supreme criminal courts in Scotland to the House of Lords.

A new tribunal has been lately erected for appeals from the Colonial courts, called the Judicial Committee of the Privy Council. It consists of the Lord President, the Lord Chancellor, and the holders of some other judicial offices when they are members of the privy council. Three members must be present to constitute an effective court, exclusive of the Lord President, who is the only unprofessional member of the court. It was constituted in 1833, and re-adjusted in 1851 (3d and 4th Will. IV., cap. 41, and 14th and 15th Vict., cap. 83). Appeal is generally the expression used for an application to revise summary judgments, as where the decision of one or two justices of peace may be referred to the quarter-sessions; and here, in some measure, the term retains its old meaning as a cry or appeal against injustice, since it is the remedy against the haste or ignorance with which it is not inaptly supposed that summary justice by unprofessional magistrates is administered. In Scotland the term appeal applies to the reference from the judgment of the sheriff-substitute to that of the sheriff.

In France the adoption of the nomenclature of the civil law has made the term, in its French shape of *appel*, of more comprehensive use to express references from a lower to a higher tribunal, than in this country. The general subject is briefly treated in the third book of the code of civil procedure.

The United States, in adopting the structure of the English law, brought with it the practice of appeal and writ of error, but the federal constitution and the jealousy of central power have practically restricted the operation of the system. By the constitution, the Supreme Court of the United States, is vested with "appellate jurisdiction, both as to law and fact, with such exceptions, and under such regulations, as Congress should make." It appears to be held, however, that this does not confer appellate jurisdiction, but only authorizes Congress to create it, so that it is presumed not to exist unless it be specially provided for and limited. In the words of Mr Kent, "If Congress had not provided any rule to regulate the proceedings in appeal, the Court could not exercise an appellate jurisdiction; and if a rule be provided, the Court could not depart from it. In pursuance of this principle the Court decided in *Clarke* v. *Bazadone*, that a writ of error did not lie to that court from a court of the United States territory north-west of the Ohio, because the Act had not authorzied an appeal or writ of error from such a court."—(*Commentaries*, i., 324.)

Appellant ‖ Appellation.

A peculiar and pernicious process which existed until a late period in English criminal law, received the name of appeal. It was a right of prosecution possessed as a personal privilege by an injured party, of which the Crown could not deprive him, directly or indirectly, since he could use it alike when the prisoner was tried and acquitted, and when he was convicted and pardoned. It was chiefly known in practice as the privilege of the nearest relation of a murdered person, and was generally employed when the public passions were roused against the accused, on account, not so much of the evidence against him as the atrocity of the crime. Thus, after Colonel Oglethorpe's inquiry and report on the London prisons, when, in 1729, Banbridge and the other jailors were acquitted on indictments for deficiency of evidence, they were hotly pursued by appeals of murder. In the case of Slaughterford, in 1708, the public indignation was roused by the atrocity with which the accused was charged with murdering the woman he had seduced. The evidence was very imperfect, and he was acquitted on indictment; but an appeal was brought, and on conviction he was hanged, as his execution was a privilege belonging to the prosecutor of which the crown could not deprive him by a pardon. In 1818 a parallel case occurred, when the appeal was ingeniously met by an offer of battle, since, if the appellee were an able-bodied man, he had the choice of the two ordeals, combat or a jury. This neutralising of one obsolete and barbarous process by another, called the attention of the legislature to the subject, and appeal in criminal cases, along with trial by battle, was abolished by 59th Geo. III., cap. 46. A curious inquiry into this subject will be found in "An argument for construing largely the right of an appellee of murder to insist on trial by battle," by E. A. Kendall. See Parliament. (J. H. B.)

APPELLANT, in *Law*, one who appeals.

APPELLATION, the name by which any thing is known or distinguished when spoken of. Nothing can be more foreign to the original meaning of many words and proper names than their present or vulgar appellations; frequently owing to the history of those things being forgotten, or an ignorance of the language in which they were expressed. Who, for example, would dream that the legal proclamation called "O yes," was a proclamation commanding the talkers to become hearers, being the French word *Oyez*, listen, retained in our courts ever since the law pleadings were held in French? Or would any person suppose that the headland on the French coast near Calais, called by our seamen Blackness, has been so entitled from its French name of *Blanc Nez*, or the *White Head-land?*

King Henry the Eighth having taken the town of Boulogne in France, the gates of which he brought to Hardes in Kent, where they are still remaining, the flatterers of that reign highly magnified this action, which, Porto Bello like, became a popular subject for signs; and the port or harbour of Boulogne, called *Boulogne Mouth*, was accordingly set up at a noted inn in Holborn. The name of the inn long outliving the sign and fame of the conquest, an ignorant painter, employed by a no less ignorant landlord to paint a new one, represented it by a bull and a large gaping human mouth; answering to the vulgar pronunciation of *bull and mouth*. The same piece of history gave being to the *bull and gate*, originally meant for Boulogne gate,

and represented by an embattled gate or entrance into a fortified town.

The *barber's pole* has been the subject of many conjectures; some conceiving it to have originated from the word *poll* or head, with several other conceits as far-fetched and as unmeaning; but the true intention of that party-coloured staff was to show that the master of the shop practised surgery, and could breathe a vein as well as mow a beard. The white band which encompasses the staff was meant to represent the fillet thus elegantly twined about it.

Nor were the *chequers*, at this time a common sign of a public-house, less expressive,—being the representation of a kind of draught-board called *tables*, and showing that there that game might be played. From their colour, which was red, and the similarity to a lattice, it was corruptly called the *red lettuce*, which word is frequently used by ancient writers to signify an ale-house.

The *Spectator* has explained the sign of the *bell-savage inn* plausibly enough, in supposing it to have been originally the figure of a beautiful female found in the woods, called in French *la belle sauvage*. But another reason has since been assigned for that appellation, namely, that the inn was once the property of Lady Arabella Savage, and familarly called *Bell Savage's Inn*, probably represented, as at present, by a bell and a savage or wild man, which was a rebus for her name; rebuses being much in fashion in the sixteenth century.

The *three gilt balls* so commonly hung out as signs at pawnbrokers' shops, by the vulgar humorously enough said to indicate that it is two to one that the things pledged are never redeemed, were in reality the arms of a set of merchants from Lombardy, who were the first that publicly lent money on pledges. They dwelt together in a street, from them named Lombard Street, in London, and also gave their name to another at Paris. The appellation of Lombard was formerly all over Europe considered as synonymous with that of usurer.

At the institution of yeomen of the guards, they used to wait at table on all great solemnities, and were ranged near the buffets. This procured them the name of *buffetiers*, not very unlike in sound to the jocular appellation of *beef-eaters*, now given them; though probably it was rather the voluntary misnomer of some wit, than an accidental corruption arising from ignorance of the French language.

The opprobrious title of *bum bayliffe*, so constantly bestowed on the sheriff's officers, is, according to Judge Blackstone, only the corruption of *bound bayliffe*, every sheriff's officer being obliged to enter into bonds and to give security for his good behaviour, previous to his appointment.

A *cordwainer* seems to have no relation to the occupation it is meant to express, which is that of a shoemaker. But *cordonier*, originally spelt *cordaunier*, is the French word for that trade; the best leather used for shoes coming originally from Cordova in Spain.

APPELLATIVE Names, in *Grammar*, in contradistinction to proper names, are such as stand for universal ideas, or a whole rank of beings, whether general or special. Thus, *fish, bird, man, city, river*, are common or appellative names; and so are *trout, eel, lobster;* for they all agree to many individuals, and some to many species.

APPENDINI, Francesco Maria, the author of a very valuable work in two volumes, 4to, entitled *Notizie Istorico Critiche sulle Antichità Storia e Letteratura di Ragusa;* but his earliest publication was an Illyrian Grammar. Appendini was born at Turin in 1768; and as a member of a religious fraternity, early sent to Ragusa. There he entered fully into the civil and literary history of his adopted country, which he discussed and illustrated with great success. When the French seized Ragusa, his merits were not overlooked by Napoleon, who placed him at the head of the Ragusan Academy; and when that little state fell into the possession of the Austrians, that government also appreciating his great merits, set him over the Normal Institution at Zara, an establishment for educating teachers for the various schools of the Illyrian provinces. He died in 1837, greatly esteemed and deeply regretted.—See Tipoldo, *Biografie.*

APPENZELL, a canton of Switzerland, the thirteenth in the confederation. It is a mountainous district in the north-east of Switzerland, entirely surrounded by the canton of St Gall. Of the chains of mountains which traverse it, some, especially in the south, attain a considerable elevation, that of Mount Sentis, the highest, being 8232 feet. Its principal river is the Sitter, besides which it is watered by several rivulets. It was at one time almost covered with pine and fir forests, abounding in game and wild animals; but in consequence of the extension of the population, these have much diminished. Peat and coal are abundant. From the general elevation of this canton the climate is cold and variable, but not unhealthy. It has an area of 152 square miles, with a population in 1850 of 54,869. The violent struggles which followed the Reformation occasioned its division into two parts in 1597—Inner Rhodes occupied by Roman Catholics, and Outer Rhodes by Protestants. Outer Rhodes comprehends about two-thirds of the canton, being its northern and western parts, and has a population of 43,599, almost all Protestants. Population of Inner Rhodes 11,270, almost all Roman Catholics. These two divisions have distinct democratic forms of government; each has a great council, the members of which are chosen by the people, and whose acts are all subject to approval by the general body of the people. Outer Rhodes sends two members to the national council, and Inner Rhodes one; the former contributing 772, and the latter 200 men to the federal army. The houses are distinguished by neatness and cleanliness, and are surrounded with gardens. Education, and the training of the young here, as throughout Switzerland, is much attended to. The inhabitants of Inner Rhodes are principally engaged in the rearing of cattle; those of Outer Rhodes in manufactures, especially cotton and linen goods, and embroidery. The capital of Inner Rhodes is Appenzell; of Outer Rhodes, Trogen.

Appenzell, the capital of Inner Rhodes in the above canton, is situated in a beautiful valley of the Sitter, seven miles south of St Gall. It has an old Gothic church, two convents, and a council-house. Pop. 3200, principally engaged in the linen trade.

APPETITE, in a general sense, the desire of enjoying some object supposed to be conducive to our happiness. This term is applied particularly to hunger, thirst, and the appetite of sex. Considered as principles of action, the appetites are distinguished by the following circumstances: —1. They take their rise from the body, and are common to us with the brutes. 2. They are not constant, but occasional. 3. They are accompanied with an uneasy sensation, which is strong or weak in proportion to the strength or weakness of the appetite.—See Stewart's *Philosophy of the Active Powers*, book i. chap. i.

APPIA Via, a way reaching from Rome through Capua to Brundusium, between 330 and 350 miles long. Appius Claudius, surnamed *Cæcus*, in the year of the city 441, carried it from the Porta Capena to Capua. (Livy, Frontinus.) It was afterwards carried on to Brundusium, but by whom, or when, is uncertain. It was laid with very hard stone, brought from a great distance, large, and squared (Diodorus); and it was so wide that several waggons could go abreast. What remains of it shows, that below the squared stones there were two other beds of prepared materials. The first, or lowest, is of rubble stones laid in mortar, the next is a bed

of gravel, both being about 3 feet in thickness. The breadth of this road is only 14 feet. Statius calls it *the queen of roads.* Its course is described by Horace, Strabo, and Antonine.

APPIAN, an eminent writer of the Roman history in Greek, under the reigns of Trajan and Adrian. He was of a good family in Alexandria in Egypt; whence he went to Rome, and there distinguished himself so well as an advocate, that he was chosen one of the procurators of the empire, and appointed to the government of a province. He did not complete the Roman history in a continued series, but wrote distinct histories of all nations that had been conquered by the Romans, in which he placed every thing relating to those nations in the proper order of time. Of all this voluminous work there remains only what treats of the Punic, Syrian, Mithridatic, and Spanish wars, with those against Hannibal, the civil wars, and the wars in Illyricum, and some fragments of the Celtic and Gallic wars. An excellent edition of Appian was published by Schweighæuser at Leipsic, in 1785, in 3 vols. 8vo. The extracts from the lost books are collected in this edition; the best edition of the text is that of Bekker, 1853.

APPIANI, the name of two eminent painters, who lived in our own times. Andrea was the best fresco painter of his age, and imitated the style of Coreggio. He was the pensioned artist to the kingdom of Italy. His best pictures are in the vice-regal palace at Milan, and in one of the churches of that city; where he was born in 1754, and died in 1814, of grief, it is said, for the loss of his patron and his pension. Francesco is said, by Lanzi, to be fully entitled as a fresco painter to notice in a history of the art. He was a pupil of Magatta, and had an agreeable style, as appears by his works at Perugia, where he principally lived. The same authority mentions that many of his easel pictures went to Britain. He was born in 1702, and died in 1792, aged 90; an instance of "vigour unexampled except in the case of Tiziano."

APPIUS CLAUDIUS, a Sabine by birth, one of the principal inhabitants of Regillum. His shining merit having drawn the envy of his fellow-citizens upon him, he retired to Rome with all his clan. Appius was admitted among the patricians, and was made consul with Publius Servilius Priscus in B.C. 495; but he was hated by the plebeians, being an austere opposer of their demands. The Claudian family continued long one of the most illustrious of the patrician families in Rome, and several in succession of the name of Appius supported the same stern character that distinguished their first founder.

APPLAUSE, an approbation of something, signified by clapping the hands, still practised in theatres. Applause, in antiquity, differed from acclamation, as the latter was articulate and performed with the voice, the former with the hands. Among the Romans applause was an artificial kind of noise made by the audience or spectators to express their satisfaction. There were three species of applause, denominated from the different noises made in them, viz., *Bombus*, *Imbrices*, and *Testæ;* the first a confused din, made either by the hands or the mouth; the second and third, by beating on a sort of sounding vessels placed in the theatres for this purpose. Persons were instructed to give applause with skill; and there were even masters who professed to teach the art. The proficients in this way let themselves out for hire to the vain-glorious among the poets, actors, &c., and were properly disposed to support a loud applause. These they called *Laudicœni* and Σοφοκλεις. At the end of the play a loud peal of applause was expected, and even asked of the audience, either by the chorus or the persons who spoke last. The formula was *Spectatores plaudite*, or *Valete et plaudite.* The plausores or applauders were divided into chori, and disposed in theatres opposite to each other, like the choristers in cathedrals, so that there was a kind of concert of applauses. The practice of keeping hired applauders (*claqueurs*) is still maintained in the French theatres.

APPLE. For the description of this fruit-tree, see HORTICULTURE.

Apples form a considerable article of commerce, and are imported to Britain chiefly from France and America. The quantity of raw apples imported from foreign countries in 1852 was 372,229 bushels, and from British possessions 2124.

APPLEBY, a small market and borough town of England, in the county of Westmoreland, of which it is the capital, 13 miles from Penrith. It is situated on a hill, which is crowned by a very ancient castle, and is almost surrounded by the river Eden, which is here crossed by a fine old stone bridge. It consists chiefly of one broad irregularly built street. Its principal buildings are the castle, two churches, market-house, town and shire halls, gaol, hospital for thirteen widows, and the grammar-school, which has six exhibitions at Queen's College, Oxford. It is governed by a mayor, twelve aldermen, and sixteen burgesses, and previous to the Reform Act, by which it was disfranchised, it sent two members to Parliament. The town possesses little trade, and its population is decreasing. In 1851 it was 883.

APPLICATION, in *Geometry*, is used either for division; for applying one quantity to another, whose areas, but not figure, shall be the same; or for transferring a given line into a circle or other figure, so that its ends shall be in the perimeter of the figure.

APPRAISER (from *ad*, to, and *pretium*, value), one who rates or sets a value upon goods, &c. It is practised by brokers of household furniture, to which set of men the word is chiefly applied; yet upholsterers and other brokers are employed, or even any person supposed to be skilled in the commodities to be appraised or valued. See AUCTIONEER.

APPREHENSION, in *Logic*, denotes the simple attention of the mind to an object presented either to our sense or our imagination, without passing a judgment or making an inference.

APPRENTICE (from *apprendre*, to learn), one who is bound by covenant to serve a tradesman or artificer a certain time, upon condition of the master's instructing him in his art or mystery.

By the common law, every person is left at liberty to follow whatever trade or employment may be agreeable to him. But as it was supposed that great injury would result to the public if unqualified persons were to exercise the various crafts and mysteries connected with the mechanical trades, it was specially provided, by the 5th Eliz., that no person should exercise any art or craft unless he had previously qualified himself for it by a regular apprenticeship, under a penalty of L.400 for every month. Considerable doubts were always entertained as to the trades to which this statute applied; and as the courts of law do not seem generally to have favoured the principle of the statute, their decisions tended rather to confine than to extend the restriction. It was at length agreed that the law was only applicable to such trades as existed at the time of passing the act, and to such also as implied some mystery or craft. The operation of the statute was also held to be limited to market-towns, it being supposed necessary, for the convenience of the inhabitants of country villages, that the same person should exercise different trades, even though he had not been regularly bred by a seven years' apprenticeship to each. These various limitations of the statute gave rise to many very absurd distinctions, which plainly showed how very unsuitable this antiquated law was to the present advanced state of the mechanical trades. It was found, for example, that a coachmaker could neither himself make nor employ journeymen to make his coach-wheels, but that it behoved him to buy them of a master wheelwright, this last trade having been

exercised in England before the 5th Eliz. But a wheelwright, though he has never served an apprenticeship to a coachmaker, might either himself make, or employ journeymen to make, coaches, the trade of a coachmaker not having been prohibited by the statute, as not being exercised in England at the time it was passed. All the great manufactures which, in modern times, have arisen throughout England—in Manchester, Birmingham, Sheffield, Wolverhampton—were on this account exempted from the restrictive operation of this law; and the perfection to which they have arrived seems a practical proof of its inutility for the encouragement of trade.

The effects of those restrictions imposed by the 5th Eliz. were at length felt to be so injurious, that, in the year 1813, petitions were presented to parliament from various manufacturing towns for a repeal of certain parts of this exceptionable statute; and the 54th Geo. III. was accordingly passed, by which all the penalties and prohibitions imposed by 5th Eliz. on those who should exercise any trade or mystery, unless qualified by six or seven years' apprenticeship, were repealed. That part of the statute was also repealed which enacted that no person should become an apprentice except in strict conformity to the provisions of the 5th Eliz., and which rendered all indentures contrary to this act null and void. In opposition to this, it was provided that all indentures or covenants which would otherwise be valid, should now be valid, anything in the 5th Eliz. to the contrary notwithstanding.

APPRENTICESHIP, the servitude of an apprentice, or the duration of his indenture.

Seven years seem anciently to have been, all over Europe, the usual term established for the duration of apprenticeships in the greater part of incorporated trades. All such incorporations were anciently called *universities*, which indeed is the proper Latin name for any incorporation whatever. The university of smiths, the university of tailors, &c., are expressions which we commonly meet with in the old charters of ancient towns. When those particular incorporations which are now peculiarly called *universities* were first established, the term of years which it was necessary to study in order to obtain the degree of master of arts, appears evidently to have been copied from the term of apprenticeship in common trades, of which the incorporations were much more ancient. As to have wrought seven years under a master properly qualified was necessary in order to entitle any person to become a master, and to have himself apprentices in a common trade; so to have studied seven years under a master properly qualified was necessary to entitle him to become a master, teacher, or doctor (words anciently synonymous), in the liberal arts, and to have scholars or apprentices (words likewise originally synonymous) to study under him.

Apprenticeships were altogether unknown to the ancients. The reciprocal duties of master and apprentice make a considerable article in every modern code. The Roman law is perfectly silent with regard to them. There is no Greek or Latin word which expresses the idea we now annex to the word apprentice—a servant bound to work at a particular trade for the benefit of a master during a term of years, upon condition that the master shall teach him that trade.

Dr Smith considers the institution of apprenticeships as a device by which trading corporations endeavour to confine to as few hands as possible the mystery of their craft, and by which, keeping the market always understocked with their particular sort of labour, they expect to regulate according to their discretion the price of such manufactures as they bring to market. He accordingly condemns all those laws which limit the number of apprentices to be taken by each master in particular trades, or which prescribe to apprentices a certain term of service before they are permitted to work as journeymen. The tendency of such laws, he observes, is to restrain the competition to a much smaller number than might otherwise be disposed to enter into the trade; the limitations of the number of apprentices restraining it *directly*, and a long apprenticeship restraining it *indirectly*, but as effectually, by increasing the expense of education. Long apprenticeships, or indeed any apprenticeship, for however short a term, Dr Smith considers quite unnecessary, as the nicest mechanical arts, such as the making of clocks and watches, contain, according to his theory, no such mystery as to require a long course of instruction. A few weeks, he calculates, or even a few days, would be sufficient to enable a mechanic to set to work in any of those trades; and if he were paid the full price for his work, he paying of course for such materials as he might spoil through awkwardness and inexperience, he imagines that he would learn his business more effectually, and be more apt to acquire habits of attention and industry, than when he works under a master who has a right to share in the produce of his labour.

It may generally be remarked, however, that, in his reasonings on these subjects, Dr Smith seems uniformly disposed to overrate the practical effect of those expedients by which corporations have been always endeavouring to secure special advantages for particular trades; and that his theory respecting apprenticeships is only a part of that more general theory by which he endeavours to show that the policy of Europe has always been to encourage the industry of the towns at the expense of that of the country; and that the effect of this policy has been to enable the merchants and manufacturers of the town, in bartering their produce for that of the country, to levy, for several centuries, an unjust and oppressive tax on the agricultural classes of the community. We know, however, that, according to the nature of human society, as it is so admirably explained in Dr Smith's work, monopoly can never succeed on so great a scale; and, on the same principle, we may rationally question, if the contract between the apprentice and his master were merely the device of corporations, whether it ever could have come into such universal use throughout Europe. The engagement by which the apprentice is bound to his master is his own voluntary act. He agrees to bind himself to work to his master at an inferior rate, on condition of receiving from his master the necessary instruction in his business. This instruction, Dr Smith asserts, may be given him in the course of a few days or a few weeks. It is well known, however, to every practical tradesman, or to any one acquainted with the nature of mechanical employments, that the instruction of three days or weeks would scarcely teach an apprentice the name of his tools, and that almost all the mechanical trades require throughout their various operations such nicety and exactness, that the necessary habits are not formed by the training of years, in place of weeks or days. It is for the troublesome superintendence of the apprentice during this period that the master exacts compensation, without which he would employ none but finished workmen. But he puts up with the awkwardness of his apprentice because he expects to be benefited by his labour after he shall be better instructed in his business; on the same principle that the farmer lays out his capital on the improvement of his land, in expectation of a future increase of produce. The contract of apprenticeship is thus a voluntary agreement between two parties for their mutual benefit, the result neither of law nor of the usages of petty corporations, but of circumstances. The law, indeed, takes cognizance of the contract, and enforces its fulfilment; and it may also have encumbered it with absurd regulations; but the contract itself stands independent both of law and usage, having its origin in the plainest principles of reciprocal expediency. There seems no reason, therefore, to class it with those artificial expedients which originate in the exclusive spirit of trading corporations.

Dr Smith appears also to have greatly overrated the effects of those laws, the object of which is to limit the number of apprentices who shall be reared to particular trades. No law of any corporation will ever be found in practice to impose any limitation on the number of apprentices who may be trained to a business. It will depend on the state of the business, whether it is advancing, stationary, or declining, what number of apprentices will be bred to it; and if, while a flourishing trade called for a continual supply of new hands, any corporation were to enact a law limiting the masters to such a number of apprentices as would barely keep up their present stock, a scarcity of hands would soon be felt, wages would rise, and the masters would soon be induced, by regard to their own interest, to rescind the law which imposed so great an inconvenience on themselves. But if the law is thus modified and accommodated to the state of the trade, it is a mere form. It imposed in reality no restraint, since it is always in the power of the masters to alter it whenever they feel that it interferes with their arrangements.

But though the law were even rigidly persisted in, it is evident that it would not permanently diminish the number of apprentices who would be bred to a business, since the consequence would be, that the workmen would turn masters, and each taking the full allowance of apprentices which the law permits, would soon train up an ample supply of hands. All those petty contrivances of corporations, therefore, though they may originate in the lowest mercantile jealousy, and though they may be exceedingly absurd, cannot materially disturb the general progress of things; and though they may harass individuals, their effect on the industry of a great country hardly deserves notice; their bad effects being corrected by those general causes on which society depends for completing its arrangements, in spite of the obstacles arising from the mistaken policy of legislators.—See Smith's *Wealth of Nations*, with Notes, and an additional volume of Dissertations, by David Buchanan. (D. B—N.)

The provision of the General Merchant Seaman's Act, 7th and 8th Vict. cap. 112, binding all vessels (except yachts) of 80 tons and upwards to carry a certain number of apprentices in proportion to their tonnage, was repealed by the Navigation Act, 12th and 13th Vict. cap. 29. The age of apprentices when bound is not material, provided they have completed their twelfth year; but no apprenticeship to the sea-service is binding after the apprentice shall have attained the age of twenty-one; when, or at the expiration of his apprenticeship, whichever shall first happen, his indenture and register-ticket are to be delivered up to him, under penalty of L.20. All the indentures of apprenticeship and assignments of sea apprentices are to be registered in the "General Register Office of Merchant-Seamen" in London, if the master shall be or reside there; or if at any other port, by the collector or comptroller of such ports. Any master or owner neglecting to deliver a counterpart, and cause the indenture or assignment to be registered within ten days, shall be liable to forfeit L.10 (G. M. S. Act, cap. 112, § 42). If, after a ship shall have proceeded on a voyage, the master shall permit any apprentice to quit, except for the purpose of entering the royal navy, such master shall be liable to forfeit L.20 (*Ibid.*); nor can he enter into that service without the consent of his master.—See Symon's *Law of Merchant Seamen;* the acts above mentioned; and the *Mercantile Marine Act.*

APPROACHES, in *Fortification*, are the *covered ways* by which the besieger tried to draw near a fortification, without exposing his men to the fire of the place. The covered way is formed by excavations advancing obliquely to the fortress, and the earth thrown out of the cut is collected between it and the works of the besieged, as an additional cover to the men; or where the ground is rocky, they are protected by baskets of earth, or bags filled with some soft material. See FORTIFICATION.

APPROXIMATION, in *Arithmetic* and *Algebra*, the coming nearer and nearer to a root, or other quantity sought, which cannot be found exactly by any known process.

APPULSE, in *Astronomy*, the approach of any planet to a conjunction with the sun or a star. It is a step towards a transit, occultation, conjunction, eclipse, &c.

APRIES, the Pharaoh Hophra of the Bible, was the 4th king of the 26th Egyptian dynasty, and succeeded his father Psammis about 595 B.C. According to Herodotus (iv. 159), he conquered the Tyrians in a naval engagement at Sidon, and re-established the Egyptian dominion over Syria. He carried his arms into Libya, but was defeated in an attempt upon Cyrene. His subjects revolted and proclaimed Amasis king, and in a battle which followed Apries was taken prisoner and strangled, B.C. 570.

APRIL (*Aprilis*), the fourth month of the year, according to the common computation; but the second according to that of the astronomers. It contains 30 days. The word is derived from *aperio*, I open, because the earth in this month begins to open her bosom for the production of vegetables.

A PRIORI and A POSTERIORI, philosophical terms, derived from a distinction of Aristotle between the order of nature and the order of human knowledge, that which is prior (πρότερον) in the one, being posterior (ὕστερον) in the other. With the followers of Aristotle, accordingly, a demonstration *a priori* is a proof from the cause to the effect, *a posteriori*, a conclusion from the effect to the cause.

The term *a priori* came afterwards improperly to be applied to any abstract reasoning from a given notion to the conditions which such notion involves, *e.g.*, to what have been called the *ontological* and *cosmological* proofs of the existence of God; the proof from experience (*e.g.*, the argument from design) being called *a posteriori.*

In modern philosophy, however, since the time of Kant (though the distinction may be traced in Hume), these counter terms are used to distinguish those elements of human knowledge which are native, necessary, and antecedent to experience, from those which are merely the data of experience. Thus, the truths of mathematics, founded on the intuitions of time and space are *a priori;* the facts of history, founded on experience, are *a posteriori.*

APRON, in *Naval Architecture*, is a piece of curved timber fixed behind the lower part of the stem, immediately above the foremost end of the keel.

APRON is also a name given to a platform or flooring of plank, raised at the entrance of a dock, against which the dock-gates are shut.

APRON, in *Gunnery*, a piece of lead which caps or covers the vent or touch-hole of a gun.

APSIS, in *Ecclesiastical Writers*, denotes an inner part in the ancient churches, wherein the clergy sat, and where the altar was placed. It is supposed to have been thus called because covered with an arch or vault of its own, by the Greeks called ἁψὶς, by the Latins *absis*. Apsis, in this sense, amounts to the same with what is otherwise called *choir*, *concha*, *camera*, and *presbyterium;* and stands opposed to the *nave* or body of the church.

APSIS is more particularly used for the bishop's seat in ancient churches. This was peculiarly called *apsis gradata*, because raised on steps above the ordinary stalls. It was also denominated *exedra*, and in latter times *tribune*.

APSIS was also used for a reliquary or case, wherein the relics of saints were kept. It took the name *apsis* from its being round or arched at the top, or perhaps from the place where it was kept. The *apsis* was commonly placed on the altar; it was usually of wood, sometimes also of gold and silver, with sculptures, &c.

APSIS, in *Astronomy*, a term used indifferently for either of the two points of a planet's orbit, where it is at the greatest or least distance from the sun or earth; and hence the line connecting those points is called the line of the *apsides*. The word is Greek, and derived from ἅπτω, *I connect.* The apsis, at the greatest distance from the sun, is

called the *aphelion*, and at the greatest distance from the earth the *apogee;* while that at the least distance from the sun is termed the *perihelion*, and at the least distance from the earth the *perigee*.

APT, an arrondissement in the department of Vaucluse in France, extending over 453 square miles, or 290,288 acres. It is divided into five cantons, and 50 communes. Pop. in 1851, 55,916.

Apt (*Apta Julia*), capital of the arrondissement of that name, situated in a rich valley on the left bank of the river Calavon, and surrounded by old walls. It is the seat of a bishop, and has a court of primary jurisdiction, a society of agriculture, and a college. Population in 1851, 5699, engaged in the manufacture of woollen and cotton stuffs, confections, brandy, earthenware; also in silk-spinning, blanching wax, &c.; besides which they export grain, wines, truffles, almonds, fruits, and cattle. Apt, one of the most ancient cities of Gaul, was restored by Julius Cæsar, who built across the river a fine bridge of one arch, which still exists. The Gothic cathedral is of high antiquity, and the town presents various objects of antiquarian interest. Long. 5. 23. 47. E. Lat. 43. 52. 29. N.

APTERYX (from α, priv., and πτέρυξ), a singular genus of absolutely wingless birds found in New Zealand. See Ornithology.

APTHANE, a title anciently given to the higher degrees of nobility in Scotland. See Thane.

APULEIUS, Lucius, a Platonic philosopher, well known by his performance entitled *Metamorphoses, or the Golden Ass.* He was born at Madaura, a Roman colony in Africa, about the year 128, and died probably about the end of the reign of the second Antonine. He studied first at Carthage, then at Athens, and afterwards at Rome, where he learned the Latin tongue without the help of a master. He was a man of a curious and inquisitive disposition, especially in religious matters. This prompted him to take several journeys, and to enter into various religious societies. He spent almost his whole fortune in travelling; so that on his return to Rome, when he was about to dedicate himself to the service of Osiris, he had not money enough to defray the expense attending the ceremonies of the reception, and was obliged to pawn his clothes to raise the necessary sum. He supported himself afterwards by pleading at the courts; and being a great master of eloquence, and of a subtile genius, he was entrusted with many important causes. But he benefited himself more by marrying a rich widow named *Pudentilla.* This marriage, however, drew upon him a troublesome lawsuit. His wife's relations, pretending that he had made use of sorcery to gain her heart and money, accused him of being a magician before Claudius Maximus, proconsul of Africa. Apuleius found no great difficulty in making a successful defence. His *Apology*, which is still extant, contains some very curious details. Apuleius was indefatigable in his studies, and composed many works, some in verse, and others in prose; but most of them have been lost. He took great pleasure in declaiming, and was heard generally with applause. The citizens of Carthage erected a statue to him, and several other cities did him the same honour.

The editions of his works have been very numerous; the first and rarest was printed at Rome in 1469, and an excellent one was published at Leyden in 1786–1823, in 3 vols. 4to. This edition was begun by Oudendorp, and published after his death by Ruhnkenius and Bosscha. A very elaborate edition of his whole works was published at Leipzig in 1842, by G. F. Hildebrand. His principal pieces, besides the celebrated fiction of the *Golden Ass*, are his *Apology*, entitled *Oratio de Magia;* fragments of speeches, entitled *Florida;* three books of philosophy, entitled *De Habitudine Doctrinarum et Nativitate Platonis;* and a curious treatise, *De Deo Socratis.*

APULIA, a subdivision of ancient Italy. It had Lucania on the south, Samnium on the west, the river Tifernus on the north, and the Adriatic on the east. It formed a part of the Japygia of the early Greeks. It was successively under the Romans, the Goths, the Lombards, and the Saracens. The Normans of Sicily conquered it, and it now, as *Puglia*, forms the Neapolitan provinces of Capitanata, Bari, and Otranto.

APURE, a large river of Columbia in South America, 520 miles long, and forming one of the principal affluents of the Orinoco.

APURIMAC, a considerable river of South America, which rises in the Andes near the northern extremity of the Lake of Titicaca, about 16° south latitude, and after receiving several large tributaries, pours itself into the Marañon, about 5° south latitude; before which it has changed its name to Rio Ucayali. Its whole course is about 500 miles.

APUSCIDAMUS, a lake of Africa mentioned by Pliny (xxxi. 2), on whose surface even the heaviest bodies were said to float. Similar stories were related of several other lakes and fountains.

APYCNI (*Soni*), ἄπυκνοι (φθογγοί), among the ancient Greek writers on music, meant sounds not crowded together by small intervals. In particular, those three of the fixed or unalterable sounds of the ancient system which were called *Proslambanomenos*, *Nete synemmenôn*, and *Nete hyperbolæôn.* See Euclid's *Harmonic Introduction;* edit. Meibomius, pp. 6, 7.

APYROUS (α, priv., and πῦρ), a word applied to denote that property of some bodies, by which they resist the most violent fire without any sensible alteration. Apyrous bodies ought to be distinguished from those which are refractory. Refractory substances are those which cannot by violent heat be fused, whatever other alteration they may sustain. But a body, properly speaking, apyrous, can neither be fused by heat, nor undergo any other change. Diamonds were long thought to be possessed of this property; but experiments have shown that diamonds may be entirely dissipated or evaporated by heat, and are therefore not entitled to be ranked among apyrous substances. Perhaps there is no body in nature essentially and rigorously apyrous. But it is sufficient that there be bodies apyrous relatively to the degree of fire which art can produce, to entitle them to that name.

AQUA, the commercial name in Scotland for malt spirit.

Aqua, a term frequently met with in the writings of physicians, chemists, &c., for certain medicines or menstruums, in a liquid form, distinguished from each other by peculiar epithets, as—

Aqua Fortis, a name given by artists to nitric acid of a certain strength, on account of its dissolving power.

Aqua Marina, a name by which the jewellers call the beryl, on account of its sea-green colour.

Aqua Regia, a compound of nitric and muriatic acid, in different proportions, according to the purpose for which it is intended. It is usually made by dissolving in nitric acid either sal ammoniac or common salt, both of which are combinations of muriatic acid with alkali.

Aqua Secunda, aqua fortis diluted with much pure water. It is employed in several arts to clear the surface of metals and certain stones.

Aqua Tofana, called also *Aqua della Toffanina* or *Aqua della Tofa*, from its inventress Tofana,—*Aqua del petesino*,[1]—*Aquetta di Napoli*, or simply *Aquetta*, a poi-

[1] Lanzoni *Opera*, vol. i. p. 69. Lausannæ, 1738, 3 vols.

Aqua Tofana.

sonous liquor which was used to a very great extent at Naples and Rome during the latter half of the 17th century. Gmelin[1] says that more people were destroyed by it than by the plague, which had prevailed a short time before it came into use; and Garelli, chief physician to the emperor, wrote to Hoffmann that Tofania confessed she had used it to poison more than 600 persons. This he learnt from the emperor himself, to whom the whole criminal process instituted against her was transmitted.[2]

It is to be regretted that Garelli, who had such an authentic source of information, has not given us some details of the infamous Tofana or Tofania, as the little that we know of her rests upon the authority of travellers, and is evidently exaggerated, and sometimes irreconcilable with established facts. She was a Sicilian by birth, and resided first at Palermo, and then at Naples. When she began to exercise her horrible profession, is nowhere stated; but it will presently appear that it must have been at a very early age, and before 1659. She was extremely liberal of her preparation, chiefly, it is said, to ladies tired of their husbands; and the better to conceal the nature of her gift, it was put up in small flat phials, inscribed *Manna of St Nicholas of Bari*, ornamented on one side with an image of the saint, that it might pass for a liquid said to drop from his tomb at Bari, which was in great request on account of the medicinal virtues ascribed to it. Nor is it ascertained how long she carried on her murderous practices with impunity and undiscovered. Labat[3] says, that when he was at Civita Vecchia in 1709, the viceroy of Naples, then Count Daun, made the discovery. It was long before she was secured, as she was extremely cautious, and often changed her abode or retired into convents. At last she was betrayed, and, although in a convent, was seized and carried to the Castel del Uovo, where she was examined. Cardinal Pignatelli, then archbishop of Naples, indignant at the violation of a religious sanctuary, threatened to excommunicate the whole city if she was not delivered up to him; and the people were ready to rise. But the sagacious viceroy caused a report to be spread that she and her accomplices had determined upon the same day to poison all the springs in the city, the fruits brought to market, and the public granaries. The manœuvre succeeded. The credulous people were now clamorous for her punishment, and saw with satisfaction the persons whom she accused of having purchased her *Aquetta* taken from the churches and monasteries. Some of inferior birth were executed publicly, those of higher rank secretly in prison; and the whole city resounded with the praises of the viceroy, whose energy had saved it from general destruction. A kind of compromise was entered into with the cardinal; in consequence of which, after being strangled, her body was thrown at night into the court of the convent, by way of testifying some respect for the rights of the church. But the reverend traveller must have either been misinformed as to the actual execution of this Medea, or she must have been resuscitated; for Garelli expressly says that she was alive in prison at Naples when he wrote to Hoffmann, not long before 1718; and Keysler, who visited Naples in 1730,[4] likewise asserts that she was then living in prison, and that few strangers left the city without going to see her. He describes her as a little and very old woman.

The Roman ladies very quickly availed themselves of Tofania's discovery; for it was remarked in 1659, that many husbands died when they became disagreeable to their wives; and several of the clergy also gave information that, for some time past, various persons had confessed themselves guilty of poisoning. This led to the detection of a society of young married women (who had for their president an old woman of the name of Hieronyma Spara, a pretended fortune-teller), as the perpetrators of these murders. On being put to the torture they all confessed except Spara, who seemed to rely upon the protection of powerful individuals whom she had formerly served. But she was left to her fate, and was hanged along with her assistant, one Gratiosa. Others were afterwards hanged, or whipt and banished. Spara, who was a Sicilian, had acquired her knowledge from Tofania at Palermo.[5]

Pope Alexander VII., immediately on the discovery and punishment of those who dealt in poison in his capital, published an edict forbidding the distillation of aqua fortis, or the purchase of any of its ingredients, without the permission of the government; which Gmelin considers as an artifice to mislead the people as to the real composition of the poison, or as originating in the absurd nomenclature of the chemists of former times, who called arsenic concrete aqua fortis. But the prudence of the Pope was rendered fruitless; for we are informed by Gayot di Pitaval (*Causes Celèbres*, vol. i. p. 317, Amsterd. 1764), on what authority he does not state, that Tofania's fatal secret was disclosed by the indiscretion of the judges at Naples, to whom she had made confession of her crime. The whole city soon knew that she employed in its composition a very common herb, and that its preparation was otherwise easy; and in this way the art of poisoning became very common in Naples, where, Keysler says, it was still secretly practised when he visited Italy; and Archenholz,[6] who was there in 1780, states, that Aqua Tofana was then in use, although its composition was only known to a few; but Joseph Frank, who was long professor in Pavia, and has written a work on toxicology (*Handbuch der Toxicologie*, p. 168, Wien, 1803), regards this as an unfounded calumny, and asserts that it no longer exists or is heard of.

Aqua Tofana is described as being as limpid as rock water, and without taste, and hence it could be administered without exciting suspicion. The Abbé Gagliani adds,[7] that there was not a lady in Naples who had not some of it lying openly on her toilet among her perfumes, in a phial known only to herself.

It was generally believed that the effect of this poison was certain death, and that it could be so tempered or managed as to prove fatal in any determinate time, from a few days to a year or upwards. Four or six drops were reckoned a sufficient dose, and they were said to produce no violent symptoms, no vomiting, or but very seldom;

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[1] *Allgemeine Geschichte der mineralischen Gifte*, 1st edit. 8vo, Nurnberg, 1777, p. 132; 2d edit. 8vo, Erfurt, 1811, p. 243.
[2] F. Hoffmanni *Med. Rat. Syst.* P. ii. cap. ii. sect. 19. *Opera Omnia*, 6 vols. folio, Genevæ, 1748, vol. i. p. 198.
[3] *Voyage en Espagne et en Italie*, 8 tomes 8vo, Paris, 1730, vol. iv. p. 33.
[4] *Travels through Germany*, &c. 4 vols. 4to, 2d edit. London, 1756, vol. ii. p. 368.
[5] J. F. Le Bret, *Magazin zum Gebrauche der Staaten-kirchengeschichte*, iv. Frank. 1774, p. 131–141, as quoted in the curious chapter on *Secret Poisons*, in Beckmann's *History of Inventions and Discoveries*—a work which has been of great assistance to us in pointing out authorities.
[6] *England und Italien*, 5ter Theil, 8vo, Carlsruhe, 1787, p. 184.
[7] Weckherlin's *Chronologen*, 12ter Band, p. 146—*L'Espion Dévalisé. Feliciter Audax*, London, 1782, p. 61; also Behrends, in Pyl's *Magazin für gerichtliche Arzneikunde und medicinische Polizey*, book i. st. 3, 1784, p. 428–477.—Beckmann.

no pains, convulsions, inflammation, or fever;[1] but only a feeling of indisposition, without any very definite symptoms, except sometimes inextinguishable thirst: the victim, however, sunk into a languid state, and his weakness increased daily. Disgust at all kinds of food, and weariness of life, succeeded: the nobler organs were then attacked, the lungs were wasted by suppuration, and death closed the miserable scene. This termination was the more certain, that the true cause of these symptoms was not at first suspected, and the remedies commonly prescribed rather aggravated the evil. Indeed, even when known, no treatment was of any avail, although a Dr Branchaletti, according to Keysler, wrote a book on its remedies, until it was discovered by accident that lemon-juice, when very early administered in large doses, sometimes proved effectual (Bertholinus), after which Keysler tells us that the poison fell into some disrepute.

Various accounts of the composition of this detestable liquor have been given. Abbé Gagliani, and more lately Archenholz, state it to be a preparation of cantharides and opium; but this is perfectly inconsistent both with its appearance and effects. By no preparation can the smell and taste of opium, if the quantity be sufficient to produce any effect, be concealed; and the acrimony of cantharides is equally connected with its activity. The one of these drugs is highly stimulant, the other a sedative, and neither of them capable of remaining latent in the system, or injuring the constitution. Erndtel,[2] but without any probability, has conjectured that the chief ingredient was lead: Halle (*Die deutchen Giftpflanzen*, Berlin, 1703) believes that it was prepared from the frothy saliva gathered round the mouth of a person tortured to death. Garelli, on the contrary, positively asserts it to have been nothing but a solution of crystallized arsenic in a large quantity of water, with the addition, for some unknown reason, of a very innocent herb, the *Antirrhinum cymbalaria*. The same account is given by Bertholinus, Lobel (*Der freymüthige Heilkunstler*, Berlin, 1786), Plenk (*Toxicologia*, p. 335), Haller,[3] Molitor (*Commerce Lit. Noric.* 1737, p. 132), and Möhsen,[4] and is received by the most judicious systematic writers, as Gmelin and Hahnemann. (*Ueber die Arsenikvergiftung*, p. 35. Leipzig, 1786, 8vo.) Wildberg,[5] however, considers its composition to be unknown.

From Italy this poison seems to have found its way to Paris. In 1672 Godin de Sainte Croix, an adventurer, who lived in a scandalous intimacy with the Marchioness Brinvilliers, was suddenly killed by suffocation, as it is said, in consequence of the falling off of a mask of glass, which he wore to protect him from the fumes of certain chemical operations about which he was employed. As he had no known relations, his effects were examined by a public officer, and among them was found a casket, containing many packets of poisonous articles, sealed up in a mysterious manner, together with a kind of last will, directing the whole to be delivered to the marchioness, and, in case of her having predeceased him, to be burnt unopened. This led to the discovery of his having been instructed in the art of preparing poison by an Italian, called Exili, with whom he had become acquainted when confined in the Bastile; and of his having furnished the marchioness with the means of poisoning her father and her two brothers, besides others on whom she tried the effect of her preparations. One of these afterwards was called from her by the name *Eau de Brinvilliers*. She is also said to have employed a powder called *Poudre de Succession*.[6] La Chaussée, who had been valet to Sainte Croix, was convicted of being accessory to these murders, and was broken alive on the wheel. The marchioness herself, who had escaped to Liege, was also seized; and her execution, which took place on the 17th of July 1676, is described with revolting levity by Madame de Sevigné in a letter to her daughter of that date.

The practice of poisoning, however, did not seem to terminate with the death of this infamous woman; and a particular court called *Chambre des Poisons*, or *Chambre Ardente*, was established in 1679, to endeavour to put an end to it. In consequence of the investigations which took place in it, many persons, some of the highest rank, especially the Duc de Luxembourg, were implicated. More than 40 persons were at one time confined in the Bastile; but it was ascertained that almost all of them had been guilty of no crime, but were merely the dupes of a few impostors, who pretended to raise spirits, foretell future events, and to possess many secrets of a similar nature. Two women, La Vigoreux and La Voisin, with the brother of the former, and a priest called Le Sage,[7] pretended fortune-tellers, were convicted of being dealers in poison, and burnt alive on the 22d of February 1680; some others were hanged, and others acquitted. This closed the proceedings of this inquisitorial court, which has been accused of being a political engine, contrived to serve the purposes of Louvois and the Marchioness de Montespan. Voltaire, however, admits that the crime of poisoning infected Paris from 1670 to 1680.

Concerning the effects of the *Eau de Brinvilliers*, Pitaval tells us (p. 271) that the marchioness's father experienced violent effects from the poison,—extraordinary vomiting, insupportable pain at the stomach, and great heat in the bowels. He died soon after his return from his country-seat to Paris. The brothers and five other persons were all taken ill, and affected with vomiting, after partaking of a tart at dinner. On their return from the country to Paris, the brothers had the appearance of persons who had been long ill; and after suffering, the one for two, and the other for three months, from nausea and vomiting, they died extremely emaciated, and as it were dried up, without fever, though experiencing a burning sensation in the stomach. On opening the bodies, the stomach and duodenum were black and tender, and the liver gangrenous and burnt. Madame Sevigné relates that the marchioness often poisoned her husband, that she might marry Sainte Croix; but that the gallant, having no desire for a wife of her disposition, as often gave the poor husband an antidote. She is also said to have attempted to poison her sister, but did not succeed; and

[1] Bertholinus alone enumerates very violent fever as its first effect. See J. J. Wepferi *Historia Cicutæ Aquaticæ*, p. 372. Lugd. Bat. 1733, 8vo.

[2] *Dissert. de Veneno salutem sistens*, Lipsiæ, 1701, § 21.

[3] *Vorlesungen über die gerichtliche Arzneikunde*, 2ter Band, p. 190.

[4] *Beschreibung einer Berlinischen Medallien-Sammlung*, 1. Th. p. 148.

[5] *Handbuch der gerichtlichen Arzeneywissenchaft*, p. 224. Berlin, 1812, 8vo.

[6] Heucher, *Mithridates, sistens præservationem Principis a veneno.* Vide ejus Opera, 4to, Lipsiæ, 1745, vol. i. p. 421; also, J. G. Arnold pr. C. G. Stentzell *De Venenis terminatis et extemporaneis, quæ Galli* les Poudres de Succession *vocant.* This powder was probably an arsenical composition; but it was supposed by Erndtel and Haller to be acetate of lead, and by Brendel (*Institutiones Medicinæ Legalis*, Halæ, 1768) to consist of lead and bismuth.

[7] Voltaire, *Siècle de Louis XIV.* chap. xxvi.

that she was in the habit of trying the effects of her poisons on the poor, and even on the patients in the Hotel Dieu, under pretence of charitably supplying them with biscuits. But Voltaire positively denies this horrible imputation, and says that she never attempted the life of her husband, who overlooked a connection of which he was the cause.

The information concerning the nature of the *Eau de Brinvilliers*, derived from the examination of Sainte Croix's famous casket, is not satisfactory. It contained poisons enough to have killed a whole community; besides opium, lunar caustic, antimony, and vitriol, more than 75 lbs. of corrosive sublimate, and two bottles of a liquid like water, with a sediment in one. The clear liquid was probably his real poison; as none of the other substances could have been given so as to produce death, without instantly being detected by their abominable taste; but what this liquid was, we can now only conjecture; for its examination, as reported by Pitaval, shows that the physicians at that time had not the slightest notion of the mode of detecting arsenic even in substance, much less in solution; and accordingly, although both the liquor and powder killed the animals to which they were given, it is candidly admitted that the poison of Sainte Croix surpassed the art and capacity of the physicians, and that it baffled all their experiments to discover its composition. We have, however, no doubt that arsenic was the only active ingredient of all these pretended secret poisons, as it is the only substance capable of explaining all the credible circumstances related of them. From the mode of administering them in small but repeated and perhaps increased doses, there was some foundation for the belief that they could be given so as to kill in any determinate time, while their failing in any instance to produce death was easily accounted for by supposing antidotes to have been administered. But although the progress of knowledge has proved that there is no such thing as such antidotes, it has on the other hand, by rendering the detection of poison easy and certain, put a stop for ever to the trade of *poisoner*, and, what is perhaps of equal importance, to the general alarm and cruel punishment of individuals, which have often resulted from natural deaths being ascribed to poison. It is not because we know less, but because we know a great deal more than our forefathers, that the art of secret poisoning seems to be lost. (A. D.)

AQUAMBOE, a country in the interior of the Gold Coast of Africa, extending 20 miles along the banks of the Rio Volta, which separates it from Aquapim, and reaching 100 miles inland. The natives are haughty, turbulent, and warlike; and their territory, though fertile, is indifferently cultivated. Like all the countries in the interior from the Gold Coast, it is now entirely subject to the preponderant power of the king of Dahomey.

AQUAPENDENTE. See FABRICIUS.

AQUAPIM, a kingdom of considerable extent in the interior of the Gold Coast of Africa, immediately behind Acra, and having on the other side Aquamboe. This country is said to vie in beauty and fertility with any in the world. It is finely diversified with wooded hills and highly-cultivated valleys, the former having usually towns and villages situated on their summits. The people are obedient to their chiefs, mild and gentle, and are chiefly employed in agriculture, which they practise with considerable diligence.

AQUARIANS, Christians in the primitive church who consecrated water in the eucharist instead of wine. This they did under pretence of abstinence and temperance, or because they thought it universally unlawful to eat flesh or drink wine. Epiphanius calls them *Encratites*, from their abstinence; St Austin, *Aquarians*, from their use of water; and Theodoret, who says they sprung from Tatian, *Hydroporastatæ*, because they offered water instead of wine. Besides these, there was another sort of Aquarians, who did not reject the use of wine as unlawful; for they administered the eucharist in wine at evening service; but in their morning assemblies they commonly used water, lest the smell of wine should discover them to the heathens.

AQUARII, in *Antiquity*, slaves who supplied the women's baths with water, called sometimes *Aquarioli*, and held in great contempt (*Juv.* vi. 331, *Fest.* p. 19). The inspectors of the conduits or water-pipes were likewise called *Aquarii*.

AQUARIUS, the WATER-BEARER, in *Astronomy*, the 11th sign of the zodiac. It is marked thus, ♒. The poets feign that Aquarius was Ganymede, whom Jupiter ravished under the shape of an eagle, and carried away into heaven to serve as a cup-bearer in the room of Hebe and Vulcan; whence the name. Others hold that the sign was thus called because when it appears in the horizon the weather usually proves rainy.

AQUATINTA ENGRAVING, so called from its near resemblance to water-colour drawings, is of modern invention, and was much practised several years ago; and though for some time past it has been less in fashion, it is a branch of the art which is still pursued to some extent.

It is performed in a variety of ways; but the most approved is by covering or immersing the copper-plate in a solution of resinous matter, rendered so in rectified spirits of wine, and by working or drawing the object which is wished to be represented, upon the plate, with a prepared pigment, commonly called the bursting ground. These solutions and grounds are made of a variety of substances, described in recipes at the end of this article.

The work is generally commenced by etching, or tracing the outline upon the plate with an etching needle or other sharp instrument, which being done, and the etching ground removed, the plate must be made particularly clean and free from grease, with whitening and water. The plate is then to be placed in a flat tin or earthen vessel, in an inclined position, and the resinous solution or ground (No. 1, &c.) poured quickly upon it from the top to the bottom, so that the superfluous ground may run off, and be preserved for after-use in a vessel so placed as to receive it. Should the subject to be engraved be a landscape, it will be advisable to allow the ground upon the plate to dry in the inclined position, because the granulation of the shade or tint has a tendency to be closer and finer in proportion as it is nearer the top of the plate; and in this way the sky is represented by the finest grain at the top, and the foreground by the coarsest at the bottom of the plate. Should the subject require an equality of tint or grain, it will be procured by reversing the inclined position of the plate backwards and forwards as quickly as possible after the ground has been poured on it. The spirit of wine will very speedily evaporate, leaving the plate dry, with the ground upon it ready for work; but in order to render it more secure, it may be held over a clear fire, with the back of the plate next the coals until the resin of the ground is a little heated, and so fixed to the plate more completely. Care must, however, be taken, in this operation, not to melt the resinous granulations so much as to cause them to unite into solid masses.

The design is now to be drawn upon the plate with the bursting ground (No. 10, &c.), exactly in the same manner as any water-colour drawing is set about: every part where a tint is required is to be covered over with the bursting ground, and the lights alone left untouched with it. When this composition is quite dry, take a broad camel-

hair pencil, such as is used for painting skies, and go over the whole surface of the plate with the varnish (No. 13). The plate is now to be surrounded with a border of wax (14), so as to retain the aqua fortis. When the varnish is dry, as much clean water must be poured upon the copper as can be contained within the border wax, and in about 15 minutes the bursting ground will burst open the varnish, and leave the aquatinta ground ready for being bit in with the diluted acid. The bursting away of the bursting ground may be aided with the help of a clean camel-hair pencil or goose-quill feather; but if the composition be properly made this will not be necessary. The plate may now be said to be ready for the first tint being bit in with the aqua fortis, which must be allowed to remain upon it until the shade is seen to be of a proper colour, when the acid must be poured off, and the plate cleaned with water, to prepare it for the second tint; which is to be accomplished in the same manner as described for the first; and thus the greatest softness of shade, and the utmost sharpness of touch in the foreground or sky, may be attained. A pair of bellows may be used to dry the plate more quickly between the bitings with the aqua fortis, and so prevent the copper from becoming corroded by the water. From the description above given, it will be obvious that in some cases the bursting ground will not be required, and that the lights alone will need to be stopped out with the varnish;—such as in fleecy white clouds, the high lights upon metallic substances, &c.; all which practice will soon suggest to the artist.

Before we proceed to describe some other modes of performing this operation, we may remark, that when very fine grounds are required, it is customary only to bite in the lightest shades with the first granulation, and then to clean the plate and lay on a second, or even a third and fourth ground, at various stages of the work. But it must be held in mind, that in proportion as the grounds are multiplied, the granulations are subdivided, and their rich grain lost; while at the same time the work is rendered less serviceable, by its casting off a smaller number of impressions.

Should the bursting ground not flow on the plate freely out of the camel-hair pencil, in consequence of the plate being greasy, it may be washed with very weak aqua fortis before commencing. If the weather should be very cold, it is difficult to obtain a good ground; on which account it will be advisable to heat the apartment with a stove to a moderate summer heat.

Dust Grounds are prepared by covering the plate with powders of various mixtures, and fixing them by holding it over a clear fire; and the operation of biting in the subject with the aqua fortis, and the painting of the objects upon the plate, may be performed in the manner above described, and either with or without the bursting grounds. The powders may be applied to the surface of the copper in a variety of ways. As good a mode as any is to cover over the top of a small box with one or two layers of muslin, and dust the powder through these layers of muslin equally upon it. For this purpose the plate will require to be a little greasy, that the powder may adhere the more readily; and when the whole surface is covered, give the plate a sharp stroke upon the back, that the superfluous particles may be disengaged.

Madame Prestel's ground, celebrated for its fineness, is produced in the following manner: The plate is placed with its face upwards in a box, about six inches deep, covered with a lid: at one end introduce through a circular hole the small end of a hair-dresser's powder machine, filled with finely pulverized resin, and work it till the plate is completely covered with the powder, which fix over a clear fire, as already described.

Spirit Grounds.

No. 1. *Resin Ground.*—One quart of double rectified spirits of wine, and ten ounces of common resin: when dissolved, a variety of granulations will be obtained by adding spirits of wine to this solution.

No. 2. *Burgundy pitch ground.*—One quart of spirits of wine and ten ounces of Burgundy pitch: the coarseness or fineness of this, as well as the former ground, is influenced by the greater or less quantity of spirits in which the pitch is dissolved.

No. 3. *Mastic ground.*—Four ounces of gum mastic to one pint of spirits of wine: this, if made a month before being used, will be found to be a good ground.

No. 4. *Animi ground.*—Eight ounces of gum animi to one quart of spirits of wine.

No. 5. *Frankincense ground.*—Twelve ounces of gum frankincense to one quart of spirits of wine.

No. 6. *Turpentine varnish ground.*—One fourth of a pint of turpentine varnish to three fourths spirits of wine makes a curious granulated ground.

All these compositions may be mixed one with another, or even two or three may be combined; and the results, interesting in consequence of the variety of granulations which will be produced, and, as mentioned before, the coarseness and fineness, will vary in proportion to the quantity of spirits which are used.

Dust Grounds.

No. 7. Equal parts of asphaltum and fine transparent resin, finely powdered separately, and afterwards completely mixed together.

No. 8. Gum sandarach finely powdered.

No. 9. Transparent resin finely powdered. These powders may be so pulverized as to produce fineness or coarseness of granulation.

Bursting Grounds.

No. 10. Half a pound of treacle, half an ounce of isinglass, and eight ounces of gum arabic, in no more water than will just dissolve them. This should be set by for a week, shaking it up twice a day: when used, a little must be poured into a cup, and as much lamp black, burnt cork, or *terra de sienna*, ground as finely as possible, added to it as will give it both body and colour. Should it be too stiff to work, add a little water.

No. 11. Half a pound of treacle, four ounces of white sugarcandy, and one ounce of gum arabic, dissolved in a little water, at least a week before using.

No. 12. Half a pound of West Indian white sugar, an ounce and a half of isinglass, and one ounce of gum dragon, dissolved in as much malt liquor of any kind as will make them liquid; set them on the fire until all are well melted, and, when cool, the composition may be used immediately. These two last recipes may be coloured with the same substances as No. 10.

No. 13. The varnish used for covering over these bursting grounds is common turpentine varnish, thinned down with turpentine to the proper consistency required.

No. 14. Border-wax is composed of equal parts of shoemaker's resin and bees-wax.

The preceding is the method for prints of one single tint. But if different colours are to be expressed, there will be required as many different plates, each plate having only the part etched upon it which is designed to be charged with its proper colour; unless (as may happen in particular subjects) some of the colours are so distant from each other as to allow the printer room to fill them in with his rubber without blending them; in which case

Aqueduct. two or more different colours may be printed from the same plate at once. Where different plates are necessary, a separate one, having a pin in each corner, must be provided as a sole or button to the aquatinta plates; and these again must be exactly fitted, having each a small hole in their corners for passing over the pins of the sole; the said pins serving the double purpose of retaining the plates successively in their due position, and of directing the printer in placing the paper exactly on each plate so as not to shift; by which means each tint or colour will be exactly received on its proper place. A landscape or similar subject, however, may be printed off at once in the different proper colours, by painting these upon the plate. In this case the colours must be pretty thick in their consistence; and the plate must be carefully wiped in the usual way after the laying on of each tint, as well as receive a general wipe upon its being charged with all the tints. For more particular information upon this art, see the third edition of Green's *Complete Aquatinta*. (W. H. L.)

AQUEDUCT, a conduit or channel for the conveyance of water. It is derived from *aqua*, water, and *ductus*, a conduit. It is applied more particularly to those structures of masonry which have been erected for the conveyance of water across valleys, to which, however, we would rather give the name of aqueduct bridges, extending the term aqueduct to the whole conduit or channel by which the water is conveyed from one place to another. The conveyance of water for the supply of large cities has in all ages formed a very important object of public economy; and aqueducts of various kinds have been in use for this purpose from the earliest times, the remains of which have been examined by travellers in different parts of the East. Pococke describes a work of this kind erected by Solomon, for conveying water from the pools and fountains near Bethlehem to Jerusalem. "The aqueduct," he says, "is built on a foundation of stone; the water runs in round earthen pipes about 10 inches diameter, which are cased with two stones, hewn out so as to fit them, and they are covered over with rough stones well cemented together; and the whole is so sunk into the ground on the side of the hills, that in many places nothing is to be seen of it." But it was in the luxurious capital of Rome that the system of aqueducts was brought to the greatest perfection, and carried to an extent which has never been equalled even in modern times, and has justly excited admiration both from the number and magnificence of the works themselves, and the prodigious quantities of water which by these means were continually poured into the city. These aqueducts extended, some of them 30, 40, and even 60 miles from the city, in one continued covered channel of stone, carried by arcades over the widest and deepest valleys, and by tunnels running in many parts for miles through mountains and through the solid rock. "If we consider attentively," says Pliny, "the quantities of water brought into the city for the use of the public, for baths, for fish-ponds, for private houses, for artificial lakes, for gardens in the neighbourhood of the city, and for villas; if we look also at the works which have been constructed for forming a regular channel for the waters—arches raised up, mountains pierced with tunnels, and valleys filled up to a level; it must be acknowledged that there is nothing in the whole world more wonderful."

Aqueducts of Ancient Rome.

For about 400 years after the building of the city the Romans were contented with the waters of the Tiber, or what was drawn from wells or from fountains in the city and its neighbourhood. But the great increase of the population rendering a more ample supply desirable, the censor Appius Claudius was the first to introduce an aqueduct to convey the waters of distant springs into the city. About thirty-nine years after this, M. Curius Dentatus brought in an additional supply from the neighbourhood of Tibur. These examples were afterwards followed by various other public men, as the wants of the city rendered new supplies necessary. Among these were Papirius, Crassus, Marcius, Agrippa, and Augustus; and most of the succeeding emperors, even Tiberius, Claudius, Caligula, Nero, and Caracalla, esteemed it an honour to connect their names with such great and useful works. Aqueduct.

Frontinus, who was appointed curator of the aqueducts by the emperor Nerva, has left the most ample account of them. According to him, there were nine great aqueducts by which the city was supplied. Five more were added by Nerva, and the number was afterwards augmented by succeeding emperors to twenty. Of these, the most remarkable were the Aqua Appia; the Old and New Anio; the Aqua Martia, which also conveyed the Aqua Julia and the Aqua Tepula; the Aqua Virginia; and the Aqua Claudia. The *Aqua Appia* was so named from the censor Appius Claudius, by whom it was constructed in the 442d year of Rome. It commenced in a field near the Via Prænestina, between the 6th and 8th mile-stones, made a circuit of 780 paces to the left, and then proceeding by a deep subterranean channel of more than 11 miles, entered the city at the Appian Way by the Porta Capena, and delivered the main body of its waters into the Campus Martius. The *Old* and *New Anio* were so called from their bringing into Rome the waters of that river. The former began above the Tiber, at the 30th mile-stone, and consisted mostly of a winding channel, carried through an extent of about 43 miles. The latter, constructed under Nero, took a higher level, running 7543 paces above ground, and then through a subterranean passage of 54,267 paces in length. The *Aqua Martia*, which owed its formation to Quintus Martius, rose from a spring distant 33 miles from Rome, made a circuit of three miles, and afterwards forming a vault of 16 feet diameter, it ran 38 miles along a series of arcades at an elevation of 70 feet. It had openings perforated at certain distances for discharging the collected air, and at different places deep cisterns, in which the water settled and deposited its sediment. On this account it was remarkable for its clear green colour, and is celebrated by Pliny for its coolness and salubrity. The *Aqua Julia* and the *Aqua Tepula* were brought to Rome by the same aqueduct as the *Aqua Martia*, but on higher levels. The whole aqueduct above the arcades was divided into three stories or channels. In the uppermost flowed the Aqua Julia, in the second the Aqua Tepula, and in the lowest the Aqua Martia. From the ruins of this combined fabric, which still subsist, it appears to have been a very superb structure. The *Aqua Virginia* was constructed by Agrippa, who laboured to improve and beautify Rome, and who, according to Pliny, formed in one year 70 pools, 105 fountains, and 130 reservoirs. It commenced at a very copious spring, in the middle of a marsh, at the distance of eight miles from the city, and ran about 12 miles, passing through a tunnel of 800 paces in length. The *Aqua Claudia*, begun by Nero and completed by Claudius, took its rise 38 miles from Rome. It formed a subterranean stream $36\frac{1}{4}$ miles in length, ran $10\frac{3}{4}$ miles along the surface of the ground, was vaulted for the space of three miles, and supported on arcades through the extent of seven miles, being carried along as high a level as to supply all the hills of Rome. It was built of hewn stone, and still continues to furnish the modern city with water of the best quality, which has hence procured it the name of *Aqua Felice*.

In all these aqueducts the channel for the waters was carried with a regular declivity from the one end to the

Aqueduct. other of the aqueduct, and such as was sufficient to carry the water easily along. In some cases the declivity, had the line been carried straight forward, would have been too great; it was therefore made to take a circuitous route, winding along the sides of the hills, and prolonging the length of the channel so as to reduce the degree of descent, and cause the water to run gently along. The whole of the channel was regularly built of stone or brick, and arched above to cover in the channel, excepting in those places where it was cut out of the solid rock. Along all the valleys and water-courses which lay in the way it was elevated by a series of arches, all raised to the level of the conduit, resting on massy pillars, and all built in the most solid and substantial manner, with brick, and often with hewn stone. The sketches of Roman aqueducts in Plate XLIV., taken from Fabrettus, will give a better idea than any description, of the manner in which the work was executed. Sometimes there was only a single arch, as in the two middle figures; sometimes, again, where the conduit was to be elevated higher, as in the right-hand figure, a double row of arches was raised, one above the other, for greater strength and security. The figure on the left hand shows two conduits or aqueducts carried in different levels along the same building. The upper one is the New Anio, the lower is the Aqua Claudia. When we consider the labour and difficulties attending the construction of such arches and arched channels of masonry, the spirit and enterprise which could have undertaken such works as are above enumerated, undaunted by the expense, or any of the other obstacles which lay in the way, appear astonishing. In this country, where bridges, canals, and other water-works have been carried to a great extent and perfection, we consider an aqueduct of six or eight arches a work of no small extent and importance. What would we think, then, of the aqueduct of the New Anio, extending 6½ miles in one continued series of arches, many of them upwards of 100 feet high! If we allow a similar number of arches in the length, we shall have in all more than 600; and yet this is nothing compared with the aqueduct of the Aqua Martia, extending 38 miles, and containing in all nearly 7000 arches. Even an aqueduct bridge of five or six miles in length appears incredible; and yet how can we otherwise translate Frontinus, where he states the lengths of all the aqueducts, and how much was above or under ground, and how much was built in arches? Of the New Anio, for instance, he says its conduit was 63 miles 700 paces in length. Of this 49 miles 200 paces consisted of a subterranean stream, and 9 miles 400 paces were above ground, of which last the higher part consisted of "substructionibus aut opere arcuato," in several places of great length; and nearer the city, at the 7th mile-stone, consisted of "substructione" 609 paces, and "opere arcuato" 6 miles 491 paces; and he adds, "These arches are the highest of any, being raised in some parts 109 feet." The term *substructio* probably means a conduit built by opening up the surface of the ground and then covering over the building with earth, as we do in such works at this day. But the term *opere arcuato* can only refer to a continued series of arches, and certainly conveys a vast idea of the extent and magnitude of such works.

The total quantity of water delivered into Rome by these aqueducts was altogether astonishing, and quite beyond what we have any conception of now, for either comfort or luxury. Strabo said truly, that whole rivers flowed through the streets of Rome. According to Frontinus, the nine earlier aqueducts delivered daily 14·018 quinaria, which corresponds to nearly 28 millions of cubic feet; and when all the aqueducts were in operation, the quantity must have amounted to 50,000,000 cubic feet; which, reckoning the population of the city at that time at a million, would give 50 feet daily, or 7 hogsheads to each individual. This is more than ten times the supply of London, which is now reckoned to be quite profuse.

Aqueducts of Modern Rome.

Of the modern aqueducts in Rome the principal are the Aqua Felice, the Aqua Virginia, and the Aqua Paulina. The first was constructed by Sixtus V. It commences at Palæstrina, about twenty-two miles from the city, and discharges itself at the Fontana di Termini. The Aqua Paulina was repaired by Pope Paul V. in the year 1612. It divides itself into two principal channels, one of which supplies Mont Janiculum, and the other the Vatican and its neighbourhood. It is conveyed from the district of Bracciano, about twenty miles distant; and three of its five streams are not inferior to small rivers. According to the calculation of Prouy, these three aqueducts, with some additional sources, deliver in twenty-four hours 5,305,000 cubic feet. This, among a population of 130,000, gives about 40 cubic feet for each individual, which is nearly equal in proportion to the supply of ancient Rome in the period of its utmost splendour.

Aqueducts of the Roman Empire.

But the system of aqueducts was not confined to the capital of Rome. It was gradually extended throughout the provinces of that vast empire; and every city and considerable town had its conduits and aqueducts for supplying it with water, many of which still remain to attest the magnificence with which these works were carried on. In Plates XLIV. and XLV. we have given a view of some of these. The first is the remains of one of the principal aqueduct bridges in the aqueduct of Antioch. It is a work of great magnitude and height, but a very rude structure. The lower part consists almost entirely of solid wall, and the upper part of a series of arches with very massy pillars. It appears, however, to be a Roman work; and there are remains of another aqueduct on a lower level, and of an older date. The water to Antioch was brought from a distance of four or five miles, from a place called Battelma, which Pococke thinks was the very spot where Daphne stood. Several springs, one of which was so large as to turn several mills, were conveyed in channels of hewn stone, and united in one main stream, which was thence conveyed along the surface of the ground in a similar channel. Across all the rivulets and valleys it was raised on arches or aqueduct bridges, some of which are very lofty, and the principal is the one exhibited in the plate, extending upwards of 700 feet in length, and upwards of 200 feet high in the deepest part. From the remains of the aqueduct in the island of Mytilene, represented from Pococke in the same plate, this appears to have been also a magnificent work. It was built of gray marble rusticated. It is much superior in point of skill to the aqueduct of Antioch, the arches being carried in two ranges throughout the building. It extended about 500 feet in length, and was about 70 or 80 feet high at the deepest part.

Aqueduct of Pyrgos.

The aqueduct or aqueduct bridge of Pyrgos, near Constantinople, forms a portion of the extensive hydraulic works with which that capital was supplied with water after it became the seat of empire. They are described by Andreossy in his voyage to the Black Sea, and account of the Thracian Bosphorus. It is a grand work, very remarkable both in design and execution, and affords a fair specimen of the style of such structures among the Romans in the middle ages. It consists of two branches, one of which only is seen in elevation in the plate; the other stood nearly at right angles to this, and is seen partly on the plan; it was hence called the Bended or Crooked Aqueduct, to distinguish it from another termed the Long Aqueduct, which was situated near the sources of the

waters. The branch seen in elevation extends 670 feet in length, and is 106 feet in height at the deepest part. It is composed of three rows of arches, those in each row increasing in width from the bottom to the top—an arrangement very properly introduced with the view of saving materials without diminishing the strength of the work. The two upper rows consisted of arches of semicircles, the lower of Gothic arches; and this circumstance serves to fix the date of the structure, as these last were not introduced until the 10th century. The breadth of the building at the base was 21 feet, and it diminished with a regular batter on each side to the top, where it was only 11 feet. The base also was protected by strong buttresses or counterforts, erected against each of the pillars. The other branch of the aqueduct was 300 feet long, and consisted of 12 semicircular arches.

This aqueduct serves to convey to Constantinople the waters of the valley of Belgrade, one of the principal sources from which the city is supplied. These are situated on the heights of Mount Hæmus, the extremity of the Balkan Mountains, which overhangs the Black Sea. The water rises about 15 miles from the city, and between three and four miles west of the village of Belgrade, in three sources, which run in three deep and very confined valleys. These unite a little below the village, and then are collected into a large reservoir. After flowing a mile or two from this reservoir, the waters are augmented by two other streams, and conveyed by a channel of stone to the Crooked Aqueduct. From this they are conveyed to another, which is the Long Aqueduct; and then, with various accessions, into a third, termed the Aqueduct of Justinian. From this they enter a vaulted conduit, which skirts the hills on the left side of the valley, and crosses a broad valley two miles below the Aqueduct of Justinian, by means of an aqueduct with a double row of arcades of a very beautiful construction. The conduit then proceeds onward in a circuitous route, till it reaches the reservoir of Egri Kapan, situated just without and on the walls of the city. From this they are conducted to the various quarters of the city, and also to the reservoir of St Sophia, which supplies the seraglio of the grand signior. The Long Aqueduct is more imposing by its extent than the Crooked one, but is far inferior in the regularity of design and disposition of the materials. It is evidently a work of the Turks. It consists of two rows of arcades, the lower being 48 in number, and the upper 50. The whole length was about 2200 feet, and the height 80 feet. The Aqueduct of Justinian is a very excellent work, and without doubt one of the finest monuments which remain to us of the middle ages. It consists of two rows of large arcades in the pointed style, with four arches in each. Those of the lower story have 52 feet of span, the upper ones 40 feet. The piers are supported by strong buttresses, and at different heights they have little arches passing through them, which relieve the deadness of the solid pillar. The length of this aqueduct is 720 feet, and the height 109 feet. This aqueduct, though it bears the name of Justinian, was probably erected in the time of Constantine.

Besides the waters of Belgrade, Constantinople was supplied from several other principal sources, one of which took its rise on the heights of the same mountains, three or four miles east of Belgrade. This was conveyed in a similar manner by an arched channel, elevated when it was necessary on aqueduct bridges, till it reached the northern parts of the city. It was in the course of this aqueduct that was constructed the contrivance of the *souterasi* or hydraulic obelisks described by Andreossy, and which has excited some attention, as being an improvement on the method of conducting water by aqueduct bridges. "The souterasi," says Andreossy, "are masses of masonry, having generally the form of a truncated pyramid or an Egyptian obelisk. To form a conduit with souterasi, we choose sources of water, the level of which is several feet higher than the reservoir by which it is to be distributed over the city. We bring the water from its sources in subterranean canals, slightly declining until we come to the borders of a valley or broken ground. We there raise on each side a souterasi, to which we adapt vertically leaden pipes of determinate diameters, placed parallel to the two opposite sides of the building. These pipes are disjoined at the upper part of the obelisk, which forms a sort of basin, with which the pipes are connected. The one permits the water to rise to the level from whence it had descended; by the other, the water descends from this level to the foot of the souterasi, where it enters another canal under ground, which conducts it to a second and to a third souterasi, where it rises and again descends, as at the last station. Here a reservoir receives it and distributes it in different directions by orifices of which the discharge is known." Again he says, "it requires but little attention to perceive that this system of conducting tubes is nothing but a series of syphons open at their upper part, and communicating with each other. The expense of a conduit by souterasi is estimated at only one fifth of that of an aqueduct with arcades." We really cannot perceive any advantage in these pyramids, further than as they serve the purpose of discharging the air which collects in the pipes. For if the water is to be conveyed in pipes across the valley, what other purpose can these columns possibly serve? They are in themselves an evident obstruction, and the water would flow more freely without any interruption of the kind. In regard to the leaden pipes, again, they would have required, with so little head pressure as is stated, to be used of very extraordinary dimensions to pass the same quantity of water as was discharged along the arched conduits. There is something, therefore, which would require explanation in this account of Andreossy regarding these pyramids, or else he has misunderstood the nature of them when he says that they supply advantageously the place of the aqueducts or arches. A train of pipes properly laid, and of proper dimensions, might do this; but what advantage the pyramids possess further than to answer the purpose of air-cocks, is not very apparent.

The other principal source from which Constantinople is supplied, is from the high grounds six or eight miles west of the town, from which it is conducted by conduits and arches, in the same manner as the others. The supply drawn from all these sources amounts, according to Andreossy, to 400,000 cubic feet per day; about two thirds of a foot to each person of a population of 600,000. The charge of the water-works at Constantinople belongs to a body of 300 Turks and 100 Albanese Greeks, who form almost an hereditary profession.

Aqueducts of Metz, Nismes, and Segovia.

Of the aqueducts which still remain as relics of Roman grandeur, the most remarkable are, the aqueduct of Metz; the aqueduct of Nismes, or the Pont du Gard; and the aqueduct of Segovia in Spain. "The aqueducts of Rome," says Montfaucon, "were without doubt wonderful on account of their great length—arcades continued over the space of 40 or 50 miles; their great number, with which the Campagna of Rome was filled on every side: all this surprises us. But it must be confessed that if, without considering the total extent, we only look at any of the parts which remain round Rome, there is nothing that approached the aqueducts of Metz, of Nismes, or of Segovia." The aqueduct of Metz is represented in Plate XLV. Nearly the half of it, it will be observed, has been carried away; but there still remain a great num-

Aqueduct.

ber of arches, and enough to give an idea of the extent of the whole. It extended across the Moselle, a very considerable river, and very broad in this place; and served to convey the delicious waters of the Gorse to the city of Metz. These waters, according to Meuripe, in his history of the bishops of Metz, printed in 1634, were so abundant that they furnished water for floating the vessels every time that a naval fight was to be exhibited. They were collected into a reservoir, and from thence conducted by subterraneous canals constructed of hewn stone, and so spacious that a man could easily walk in them upright. They then passed the Moselle by means of the aqueduct, which was situated about six miles from Metz, and from thence were conducted under ground in stone channels, similar to the others, to the city, to the baths, to the place of the sea-fight, and all over the city. Judging from the drawing, this aqueduct seems to have been nearly 1000 feet in length, the arches 50 feet high at the deepest part, and 50 in number. They formed only one series, the height not requiring a double row. They were so well built and cemented together, that, excepting the middle part, which the descent of ice down the river has in the lapse of ages carried away, they have resisted, and will continue to resist, the effects of time and of the most violent seasons.

The Pont du Gard was executed by the Romans in the reign of Augustus, and was then merely an aqueduct for bringing the waters of the fountain of Hure to Nismes. It was composed of three rows of arches filling up the valley between two mountains, between which ran the river Gardon. The first row comprehended six arches, each 60 feet span, excepting one, which was the largest, and was 75 feet span; the second row contained 12 arches of the same span as the first; and the third had 36 little arches, on the top of which was the channel for conducting the water. This bridge exhibits a decided improvement and superiority over all the other Roman aqueducts, in the lightness and striking boldness of its design. The arches are wider, and the piers in proportion lighter, than any other structure of the kind previously constructed; and had the same principle been extended so as to have formed only a single row from top to bottom, it would have equalled in the skill and disposition of its materials (circumstances in which the Roman works were almost universally wanting) any of the more judicious and elegant structures of modern times. About the year 1740, this bridge, being of no more use as an aqueduct, was converted into a road-way, by widening it, or rather building in a manner another bridge to the side of it, having all the arches of the same span and dimensions. The execution of the work was attended with considerable difficulties, but these were all successfully overcome by the French engineer Pitot.

The aqueduct of Segovia, according to Culmenares, who travelled in Spain, and has written the history of Segovia, may be compared with the most wonderful works which antiquity has transmitted to us. There still remain of it 159 arches, all built with large stones, and without any cement. There are two rows of arches, one above the other, and the whole height of the edifice is 102 feet. It runs quite across the town, and passes over the greater part of the houses which lie in the hollow.

French Aqueducts.

In modern times various aqueducts have been formed after the manner of the Romans, particularly in France. The most remarkable are those which were constructed in the reign of Louis XIV., at vast expense, for conducting water from Marly to Versailles. Of these the famous aqueduct bridge of Maintenon, which was erected for conveying the waters of the river Eure to Versailles, is without doubt, in point of magnitude and height, the most magnificent structure of the kind in the world. In Plate XLV. we have given a view of a portion of this work, on the same scale as the other aqueducts here represented. Had the whole been delineated on the same scale, it would have extended to four times the breadth of the plate. It extends about 4400 feet in length, being nearly seven eighths of a mile, and upwards of 200 feet in height, and contains 242 arcades, each divided into three rows, forming in all 726 arches about 50 feet span. Of the subterranean aqueducts in France the finest is that of Arcueil, which serves to conduct water to that village. It is 44,300 feet in length, or upwards of eight miles, extending from the valley of Arcueil to the castle at the gate of St Jaques, all built of hewn stone. It is about six feet in height, and has on each side a foot-path 18 inches wide; it has a declivity of one foot in 1300. Another aqueduct of this kind is that of Rocquancourt, part of the system which brings water to Versailles; it is 11,760 feet in length, or upwards of two miles, and a declivity in its whole course of only three feet. In some parts of its course it was necessary to make excavations 80 or 90 feet deep, which rendered the execution very difficult.

The great waterworks that supply the city of Marseilles with the water of the Durance, by a canal about 60 miles in length, are among the boldest undertakings of the kind in modern times. This canal, begun in 1830, and not yet completed (1852), has already cost above L.2,000,000 sterling. It is conveyed through three chains of limestone mountains by forty-five tunnels, forming an aggregate length of 8½ miles, and across numerous valleys by aqueducts; the largest of which, the Aqueduct of Roquefavour, over the ravine of the River Arc, about 5 miles from Aix, surpasses in size and altitude the ancient Pont du Gard. The immense volume of water, which passes at the rate of 198,000 gallons per minute, is carried across as in the old Roman aqueducts by a channel of masonwork. The height of this aqueduct is 262 feet, and its length 1287. The number of cubic yards of masonry contained in it is 57,000; the total cost has been L.151,394.

Aqueduct of the Ganges.

One other aqueduct of recent construction is worthy of notice. In those parts of British India where the fall of rain is scanty and uncertain, recourse is had to artificial irrigation, and the waters of many of the rivers of the country have been rendered available for this purpose by means of public works constructed by the government. Of these the most important is the Ganges Canal, which traverses the north-western provinces of Bengal, and distributes over their vast area nearly the whole volume of the waters of the Ganges. See Ganges. The canal begins at the point where the river issues from the mountains and enters the plains of Bengal. About twenty miles from its source, the line of the canal crosses the valley of the Solani River, and the works for effecting the transit are designed on a scale worthy of the undertaking. The valley is between two and three miles in width. An earthen embankment is carried across, raised on an average between 16 and 17 feet above the surrounding country, and having a width of 350 feet at its base, and 290 feet in the upper part. This embankment forms the bed of the canal, which is protected by banks 12 feet in depth and 30 feet wide at the top. To preserve these banks from the effects of the action of the water, lines of masonry formed into steps extend on each side throughout their entire length. The Solani River is crossed by an aqueduct 920 feet long, having side walls 8 feet thick and 12 deep, the depth of the water being 10 feet. The water of the canal passes through two separate channels. That of the River Solani flows under fifteen arches, having a span of 50 feet each, constructed in the most substantial manner and springing from piers resting on blocks of masonry sunk into the bed of the river. The cost of the aqueduct was upwards

Aqueduct.

of L.160,000. In grandeur of design, solidity of construction, and, above all, in extensive utility, it may challenge competition with any similar work in the world.

Modern improvements; introduction of iron pipes.

Within the last century, the invention and improvement of the manufacture of cast iron has completely changed the mode of conducting water into cities, by the introduction of cast-iron pipes instead of the stone conduits of former times. These pipes can now be formed of almost any dimensions, and united together into a continued series, so closely as to prevent the escape of the water, even under a violent pressure arising from the altitude of the fountainhead. They enable us, therefore, to take advantage of and give effect to that grand principle in hydrostatics, that the fluid element tends continually to a level, even though it be confined in the smallest or most complicated system of pipes; so that however low it be carried in any valley, or to whatever distance, still it will rise on the opposite side to the original altitude of the fountainhead—a principle which is most important indeed in such works, seeing that by it we are not restricted, as the Romans were, almost to a perfect level in the line of the conduit. We have seen that, for the purpose of attaining this level or very gentle declivity all along the conduit, they were under the necessity of raising it by arcades continued in one unbroken series, frequently 30 or 40 miles in extent; and, in addition to this, often prolonging the length of the track by a circuitous route, turning and winding for miles out of its course, for the very purpose of increasing its length.

But the use of pipes enables us to dispense with these long arcades all raised nearly to the same level with the fountainhead; because the conduit may be varied in its level to any extent, and still will rise at last to its original altitude. The pipes, therefore, are merely laid all along the surface of the ground, with a cover of 2 or 3 feet of soil to place them beyond the reach of frost. To prevent, however, the frequent or abrupt alternations of rise and fall, any sudden inequalities in the ground are equalized by cuttings and embankments, but not to anything like the extent that would be required to raise the whole to a level. This, therefore, forms a capital improvement in the method of conducting water, and the greatest indeed which has ever been made in this important branch of practical mechanics. That it was not introduced by the Romans, is not to be ascribed, as many have done, to their ignorance of the hydrostatic principle, that the fluid would rise to a level in the opposite branches of the same train of pipes. Professor Leslie has shown that they were well acquainted with this principle, and has moreover obtained from Italy a portion of a leaden pipe, supposed to have been used in the baths of Caracalla, which sets this matter at rest. But, from the low state of the arts at that period, they were unable to give effect to the principle. They had not the means of fabricating pipes of such a magnitude as would have been required for the enormous quantities of water consumed in Rome, and at the same time of strength sufficient to withstand the pressure from the fountainhead. Lead was the only material that could be used by them for the purpose; and besides the enormous thickness that so weak a material would have required, and the impracticability of their forming them, and uniting them together endwise, they were too well acquainted with the tendency of lead to render the water unwholesome by its poisonous impregnation. The use of cast iron was quite unknown. There remained, therefore, no resource but in the aqueducts, which, though attended no doubt with vast expense, and requiring great enterprise, as well as both skill and patience, were yet attainable by these means, and formed when completed a simple and very perfect mode of effecting the object. Hence arose all those works above described which have since excited such astonishment. Now, however, when the manufacture of cast iron has been brought to such perfection, and methods contrived for uniting perfectly together all the pipes into one connected train, this improved system has been universally adopted.

Croton Aqueduct.

The Croton aqueduct, by which the city of New York is supplied with water, may be regarded as the most magnificent work of the kind executed in modern times. It was commenced in 1837, and completed in 1842, at an expense of 8,575,000 dollars, the distribution pipes costing 1,800,000 dollars additional. Its length from the Croton lake to the receiving reservoir is $38\frac{1}{4}$ miles. The Croton lake, which is formed by the Croton Creek, a small stream of wholesome water falling into the Hudson, covers 400 acres, and contains a body of water of about 500,000,000 gallons. To the valley of the Harlem river, a distance of 33 miles, the aqueduct is built of stone, brick, and cement, arched over and under, 6 feet 3 inches wide at the bottom, 7 feet 8 inches at the top, and 8 feet 5 inches high; and capable of discharging 60,000,000 gallons per day. It is carried over the Harlem valley in iron pipes laid upon a magnificent bridge 1460 feet long, constructed of arches 114 feet above high-water mark at Yorkville. These pipes pass into the receiving reservoir, which is 1826 feet long and 836 feet wide, covering an area of 37 acres, and capable of containing 150,000,000 gallons. Hence, to the distributing reservoir, a distance of $2\frac{1}{4}$ miles, the water is conveyed by a double line of iron pipes 3 feet in diameter. This second reservoir is 420 feet square and 44 feet above the streets, with a capacity of 20,000,000 gallons,—whence the water is conveyed through the city by about 170 miles of pipe principally from 6 to 12 inches in diameter.

Edinburgh water-works.

The works undertaken by the Edinburgh Water Company in 1819 were probably the most complete and perfect of the time. They were designed by Mr Jardine, the then engineer of the company, and carried out under his superintendence in a style quite worthy of the city, and offering, both in the general design and in all the details, a model of propriety and skill in this species of hydraulic architecture. The Crawley springs were conducted by an aqueduct into a covered cistern at a point about 7 miles distant from Edinburgh, and a supply from the stream called the Glencorse Burn, conveyed by an open-work tunnel from about a mile and a half westward. This tunnel is in some places upwards of 30 feet deep, and the valley through which it passes, consisting entirely of gravel, acts as a filter through which the water descends and percolates, all solid matter being intercepted in its passage to the tunnel from whence it is delivered into the cistern, and conveyed to Edinburgh by a chain of pipes varying from 20 to 15 inches of interior diameter, without being exposed to the light of day. From the numerous undulations of the surface, the fall of the pipe is not uniform. Abrupt inequalities, however, were removed by cutting and embanking. Towards the northern termination of the line the pipe is carried through a tunnel of 2160 feet in length and about 70 or 80 feet under the surface of Heriot's Green. In crossing the Grassmarket it forks off by one branch to a reservoir in the Castlehill, and by another about 120 feet under the reservoir, through a tunnel 740 feet in length, cut through the rock of which the ridge leading to the Castle is composed. Branches were laid through all the principal streets.

The pipes are in lengths of $9\frac{1}{2}$ feet each, and were tested before being laid by a pressure equal to a vertical column of 800 feet of water. The joints are what are termed spigot and faucet. Cocks for the discharge of air accumulating in the pipes are placed at the summits of all the considerable elevations; and in the hollows are placed sluice cocks for the purpose of running off sand or other solid matter which may collect in the pipe. It is capable of delivering 253·56 cubic feet of water per minute into the reservoir at the Castlehill.

The formation of the Compensation Reservoir, was un-

Aqueduct. doubtedly the greatest work of hydraulic engineering of its day. It was designed and completed by Mr Jardine, and with the then limited experience of contractors and workmen in the construction of similar works, its successful completion does great honour to the genius and perseverance of the engineer. It has been twice enlarged, and now forms an artificial lake extending over an area of 46 imperial acres.

In 1843 the Company obtained the authority of Parliament to bring in the Black Springs and those of Listonshiells and Bavelaw. These springs are situated on the northern margin of the Pentlands; the Black Springs fully 9 miles, those of Bavelaw upwards of 10, and the Listonshiells between 12 and 13 miles distant from Edinburgh, in a direction early south-west by west. The Black Springs vary from ten cubic feet per minute to as high as 240. The Listonshiells and Bavelaw from 135 to 170. The quality of these waters is nearly uniform, and of great purity and excellence.

In the autumn of 1847, the springs of Bavelaw and Listonshiells, about 40 in number, were made available by being conveyed in clay pipes into a stone cistern at a place called Westrigg, about 12 miles distant from Edinburgh. They are thence conveyed for nearly five miles through an aqueduct to a point at the south-west end of Torphin Hill, and thence to Edinburgh by an iron pipe of 16 inches interior diameter. Compensation to the millowners on Bavelaw Burn and Water of Leith was provided by the construction of two reservoirs at Threepmuir and Harlaw, capable of containing about 68,000,000 of cubic feet. These reservoirs form one continuous chain, with not more than 30 feet of difference of level between them when full, and together occupy an area of fully 200 acres.

In the same year the Company constructed a new reservoir in the Glencorse valley, at a place called Loganlea; about a mile to the westward of the Compensation reservoir already referred to; two more on the northern side of the Pentland ridge at Clubbiedean and Torduff; another on the site of two old ones which had been long disused, in a flat and hollow part of the hill to the south of Bonally.

Glencorse reservoir increased its capacity from 46,242,045 to 55,160,409 cubic feet. The Loganlea reservoir contains 18,801,858; the Clubbiedean, 9,836,000; the Torduff, 17,821,459, and the Bonally, 8,000,000 cubic feet. The total storage in these reservoirs is 109,619,786 cubic feet, and their capacity is estimated to be equal to a supply of 350 cubic feet per minute for a period of four months without rain.

The delivery of water over a great part of the years 1851 and 1852 has been upwards of 520 cubic feet per minute, and estimating the population dependent on them for a supply, including the town of Leith, to which a supply was extended in 1826, and Portobello, which was supplied in 1851, at 190,000, even the present limited supply is equal to nearly 25 gallons per head per day of that population. When the whole works are completed and in full operation, this supply will not only be considerably augmented, but will be made secure.

Filters on a large scale, and on the most modern principle, have been provided at Glencorse for the purification of the water that may be taken out of the burn.

The works, under the Act of 1847, were designed by Messrs Rendel and Beardmore of London, and carried out under the superintendence of Mr Leslie of Edinburgh, the Company's engineer. The capital expended in these works amounts to L.410,000, while it is understood that a sum of L.20,000 or L.30,000 more will be required for their completion.

In all places such as the above, where there is a deficiency of level to carry the water naturally to the highest parts of the town, there is no resource but in the employment of machinery. Steam power is most commonly applied to this purpose, and the water is generally either forced into a reservoir of sufficient height to supply the houses therefrom by natural gravitation, as in the city of York; or, it may be forced over upright pipes called stand-pipes, as is the practice in some of the water-works which supply London; or it may be propelled to the houses through a train of street-pipes, as is partially the practice in Glasgow. Aqueduct.

Aqueduct bridges or canals.

But though the system of pipes has thus superseded the use of stone channels all raised to a level in the conveyance of water, there are still cases, such as those of canals, where the water must be kept on a perfect level, and where, therefore, aqueduct bridges are still necessary in conveying it over the valleys; and of these we have long had examples in France, on the Languedoc canal. The first aqueduct bridges for canals in this country were those made by the Duke of Bridgewater, under the direction of the celebrated Brindley, and which, being quite new here, excited no small degree of astonishment. The first and largest was the aqueduct at Barton Bridge for conveying the canal across the Irwell, 39 feet above the surface of the water. It consisted of three arches, the middle one 63 feet span, and admitting under it the largest barges navigating the Irwell with sails set. It was commenced in September 1760; and in July of the following year the spectacle was first presented in this country, of vessels floating and sailing across the course of the river, while others in the river itself were passing under them. Since that period canal aqueducts have become more common; and many excellent examples are to be found both in England and Scotland. Of these are the aqueducts over the river Lune, on the Lancaster canal, designed by Rennie. a very excellent and splendid work of five arches, each 72 feet span, and rising 65 feet above the level of the river; and the Kelvin aqueduct, near Glasgow, which conveys the Forth and Clyde canal over the valley of Kelvin, consisting of four arches, each 70 feet span, and rising 70 feet above the level of the river. In Plate XLV., we have given views of three other principal aqueducts, viz., the aqueducts of Pont-y-Cysyllte, of Chirk, and of Slateford near Edinburgh. Of these the Pont-y-Cysyllte by Mr Telford is justly celebrated for its magnitude, for the simplicity of the design, and the skilful disposition of the parts, combining lightness with strength in a degree seldom attempted. This aqueduct serves to convey the waters of the Ellesmere canal across the Dee and the vale of Llangollen, which it traverses. The channel for the water is made of cast iron, supported on cast-iron ribs or arches, and these resting on pillars of stone. The iron being much lighter than stone arches, this is one reason why the pillars have been reduced apparently to such slender dimensions. They are quite strong enough, however, as experience has proved. The whole length of the aqueduct is about 1000 feet, and consists of 19 arches, each 45 feet span. The breadth of the pillars at the top is 8 feet, and the height of the four middle ones is 115 feet to the springing. The pillars have a slight taper, the breadth of the middle ones at the base being 15 feet. The height from the surface of the water in the Dee to that in the canal was to be 126 feet eight inches. The channel for the water consists of cast-iron plates, cast with flanches, and these screwed together with bolts; they are represented in the drawing, between the arched ribs and the railing. The lines there show the joinings of the different plates. In order to preserve as much water-way as possible, the channel is made the full width of the canal and towing-path, and the latter projected over one side, and supported inside by posts resting on the bottom of the canal. The aqueduct of Chirk was designed by the same able engineer, and serves also to convey across a valley the waters of the same canal. This aqueduct was the first in which any iron was employed. Hitherto the channel for the waters had been constructed of stone, or partly of stone and partly of clay puddle, which it was generally found very difficult to

keep water-tight for a length of time. It was determined, therefore, by Mr Telford, to try the effect of cast iron, and to lay it at first only on the bottom. The plates were accordingly laid directly over the sprandril walls, which they served to bind together, and united by flanches and screws. The sides of the channel were built with stone facings and brick hearting laid in water-lime mortar. This plan has succeeded completely, and the quantity of masonry in the aqueduct was thereby greatly reduced. The aqueduct itself is 600 feet long, and 65 feet high above the river, consisting of ten arches, each 42 feet span. The piers are ten feet thick.

The aqueduct of Slateford conveys the waters of the Edinburgh and Glasgow Union Canal across the valley of the Water of Leith at Slateford. It is an elegant structure, similar in plan to that of Chirk, only that the water-channel is composed entirely of cast iron, which is moreover built in with masonry. It is about 500 feet in length, and consists of eight arches, each 45 feet span; and the height of the canal is about 70 feet above the level of the river. On this canal another aqueduct of the very same construction occurs in crossing the valley of the Almond, and having several more arches. There are, in different parts of the country, various other aqueducts, which might be described, did our limits permit. It is the less necessary, as, excepting the formation of the water-way, these structures differ in no respect from bridges, particularly those undertaken not so much with the view of crossing rivers as of raising the level of the road entirely out of the valley,—an object now become of great importance, from the improvements within the last half-century in our modes of conveyance. Formerly people were content to traverse slowly all the inequalities of the country through which the road might pass, descending into the valleys, and mounting the steepest acclivities. Now, however, a road is thought imperfect, and quite behind the standard of improvement, unless every rise greater than 1 in 15 or 1 in 20 feet be cut down. In crossing the valleys, therefore, it is not enough now that we build a bridge in all respect sufficient for crossing the stream itself; we must raise it nearly to a level with the ground on each side of the valley; and this gives rise to new and very extensive works of this kind. Of these we may just instance the splendid bridge of one arch of 140 feet span, built over the Den Burn at Aberdeen, to form a new access into that town; also the beautiful bridge of Cartland Craigs, built by Mr Telford, over the little stream of the Mouse, on the new road from Glasgow to Carlisle, consisting of three arches 50 feet span, and elevated 130 feet above the bed of the stream. More recently the introduction of railways has opened a new and still wider field for the skill and talents of the engineer in the erection of such works. This species of road, it is well known, must be kept still more nearly on a level than any of the roads of the ordinary construction. (See RAILWAY.) In this respect the railway is somewhat similar to the old Roman aqueducts, and, where the country is low, must in like manner be elevated on a series of arcades. These bridges have received the name of *Viaducts;* there is an extensive one on the Liverpool and Manchester railway, termed the Sankey Viaduct, of nine arches; and numerous others have since been constructed throughout the country. But for the principles and mode of construction of these works, as well as of the aqueduct bridges, so far as the arch is concerned, we refer to the articles ARCH and BRIDGE; and for further information on the subject of aqueducts, see Julius Frontinus, *De Aquæductibus Urbis Romæ;* Raphaelis Fabretti *De Aquis et Aquæductibus Veteris Romæ Dissertatio;* Famiani Nardini *Roma Vetus*, lib. viii. cap. iv.; Plinii *Hist. Nat.* lib. xxxvi. cap. xv.; Montfaucon, *Antiquité Expliquée*, tome iv. tab. 128; Governor Pownall's *Notes and Description of Antiquities in the Provincia Romana of Gaul;* Belidor's *Architecture Hydraulique*, containing a drawing of the aqueduct of Maintenon; also *Mém. Acad. Par.;* Andreossy, *Voyage à l'Embouchure de la Mer Noire, ou Essai sur le Bosphore; Philosophical Transactions Abridged*, vol. i.; and Link's *Travels in Portugal.* (G. B.)

AQUILA. See ASTRONOMY.

AQUILA (Ἀκύλας), a native of Pontus, who flourished about A.D. 130, celebrated for his translation of the Hebrew Scriptures into Greek. His history is involved in much obscurity; but, according to the account of Epiphanius (*De Pond. et Mens*, c. 15), he was a kinsman of the Emperor Hadrian, who employed him in rebuilding Jerusalem (Ælia Capitolina). He was converted to Christianity, but on being reproved for practising the pagan astrology, he apostatized to Judaism. His version was very literal, and was used in place of the Septuagint in the synagogues. (*Novell.* 146.) Though the Christians generally disliked it, Jerome and Origen sometimes speak in its praise. The second edition was named κατ' ἀκρίβειαν, for its literal accuracy. The few fragments that remain are published in the *Hexapla* of Origen, and in Dathe's *Opuscula*, Lips. 1746.

AQUILA, a fortified city of the kingdom of Naples, and chief of the province Abruzzo Ulteriore Seconda. It is situated on the Aterno, in the vale of Aquila and Pescara, and is well built. Exclusive of the cathedral, it has no fewer than 24 churches, besides numerous monastic houses, while the population does not exceed 12,000 persons. It was founded in 1240, and soon became a very flourishing city; but war, pestilence, and especially the earthquakes of 1688, 1703, and 1706, have conspired to reduce it to its present state. The manufactures are linen and wax, with a considerable trade in saffron grown in the vicinity. It has a royal college, schools, hospitals, and a handsome theatre.

AQUILA, the principal standard of a Roman legion. The standard of Romulus is said to have consisted of a handful of hay, straw, or fern, affixed to a pole or spear; whence the company of soldiers who served under it was called *Manipulus.* This primitive standard was soon superseded by the figures of animals, which, as Pliny tells us (*H. N.* x. 4), were the eagle, wolf, minotaur, horse, and boar: but in B.C. 104 the eagle was permanently adopted. It was made of silver or bronze, and was represented with expanded wings.

AQUILEIA, an ancient Italian city, stormed and destroyed by Attila A.D. 452. It was recovered by Narses from the Huns, but it never regained its pristine grandeur. Before that period this Roman colony was 12 miles in circumference, and was a place of great wealth and magnificence. It was among the oldest bishop's sees in Italy, and in the sixth century its bishops had long contests with Rome. The Venetians, in 1420, conquered the adjacent country; and now Aquileia, with Udine and Friuli, forms a part of the Austrian circle of Goritza.

AQUINAS, or D'AQUINO, THOMAS, commonly called St Thomas, the greatest philosopher and theologian of the middle ages, was of noble descent, and nearly allied to several of the royal houses of Europe. He was born, according to the most probable opinion, in the year 1227, at Rocca Sicca, the castle of his father Landulf, Count of Aquino. Having received his elementary education at the monastery of Monte Cassino, he studied for six years at the university of Naples. The rising order of St Dominic numbered at that time many men of eminent energy and talents, zealous for the extension of their brotherhood, and particularly eager to draw into their ranks whatever of youthful genius and enthusiasm came within the range of their influence. The young Aquinas was soon led to choose a profession so congenial to his nature; and in direct opposition to the wishes of his family, embraced at the age of 17 the habit of St Dominic. His mother attempted in vain to rescue her son from the hands of the Dominicans, who first removed him to Rome and then attempted to convey him to Paris. His two brothers, officers in the

Tuscan army, were directed to intercept the passage of the travellers, who had proceeded no farther than Acquapendente, when the young friar was suddenly seized while reposing by a wayside fountain, and carried back to Rocca Sicca. Here he was kept for two years in close confinement, while his relatives exhausted in vain every argument and temptation which could have moved a less resolute spirit from its steadfastness. He employed his solitude profitably in meditation and study, having procured through his sisters a Bible, the Logic of Aristotle, and the Sentences of Lombard. Having at length succeeded in making his escape, he at once joined the Dominicans at Naples, and was soon after sent to study under Albert the Great, at Cologne. Here his taciturn and meditative deportment excited the contempt of his more loquacious fellow-students, who bestowed on him the title of *the Dumb Ox of Sicily*. His great teacher discerning better the profound genius of his silent pupil, told them that "When the dumb ox began to bellow, he would fill the world with the sound of his voice."

In 1245, Aquinas followed his master to Paris, returning with him at the end of three years to Cologne. In 1253 he again went to Paris, to fulfil the customary term of three years for obtaining his degree as doctor of theology. His lectures during that time were attended by crowds of enthusiastic scholars. The reception of his degree was obstructed by the contest of his order with the University of Paris, headed by William of St Amour. Both parties were summoned to plead their cause at Rome. Aquinas appeared as the champion of the mendicant orders, and the result of his powerful pleading was the condemnation of his adversary. In October 1257, he received his degree on the same day with his saintly friend Bonaventura.

For three years longer he continued at Paris, assiduous in teaching, preaching, and writing, His relative Louis IX. invited him frequently to the court, and sought his counsel on state affairs. The story of his one day startling the company at the royal table by exclaiming, out of an absorbing fit of meditation, "*Conclusum est contra Manichæos!*" is perhaps more generally familiar than his pointed reply to Pope Innocent IV. Aquinas found the Holy Father seated by a table covered with piles of indulgence-money. "You see," said the Pontiff, "the church is no longer in the days when she could say, 'Silver and gold have I none.'" "True, Holy Father," said Aquinas, "and she is therefore as little able to say to the sick of the palsy '*Rise up and walk.*'"

In 1261 Aquinas was summoned to Rome by Urban IV., and for several years lectured there and in the principal cities of Italy. In 1263 he attended the Dominican chapter held in London. Two years after he declined the offer made to him by Clement IV. of the archbishopric of Naples, as well as the more congenial office of Abbot of Monte Cassino. In 1269 he again visited Paris; and in 1272 was recalled to Naples. In January 1274 he was summoned by Pope Gregory X. to attend the council convoked at Lyons to settle the differences between the Greek and Latin churches. Though suffering from illness, he at once set out on the journey. Finding his strength failing on the way, he was carried to the Cistercian monastery of Fossa Nuova, in the diocese of Terracina, quoting, as he entered the cloister, the words of the psalm "Hæc requies mea in sæcula sæculorum!" After lingering for some weeks, he expired on the 7th of March 1274. About a century after, his body, for the possession of which many cities had eagerly contested, was removed to Toulouse, and buried with much pomp in the Dominican Church.

The highest honours which the church could bestow were awarded to the memory of Aquinas. *The Angelic and Universal Doctor, the Angel of the Schools, and the Eagle of Theologians,* were among the admiring titles conferred on the greatest of the schoolmen. He was canonized in 1323 by Pope John XXII.; and in 1567 Pius V. ranked the festival of St Thomas with those of the four great Latin doctors, Ambrose, Augustine, Jerome, and Gregory. Still higher is the honour implied in the fact that the repeated testimony of the church has stamped the authority of Aquinas with a kind of minor infallibility.

Any just estimate of his character and works would involve a view of the whole scholastic system, which attained in him its highest and most comprehensive development. The most philosophical of all the schoolmen, as his master Albert was the most learned, he consummated the harmony of the Aristotelic philosophy with the doctrines of the church; and to him mainly was due their all but exclusive empire till the era of the Reformation. With reference solely to his ethical system, Sir James Mackintosh (*Prelim. Diss.*, p. 328) speaks of Aquinas as "the moral master of Christendom for three centuries." Those, indeed, who are accustomed to regard the scholastic philosophy indiscriminately as a system of mere laborious trifling, may find some scope for ridicule in the endless divisions and subtle questions of the Angelic Doctor on the nature and properties of angels and other impractical themes; but if the unvarying dialectical force and the occasional profound suggestiveness arouse no sympathy with the mediæval admiration of "friar Thomas and his goodly lore," it is to be feared that the fault is not wholly with the writer. The mental fecundity which in so brief and interrupted a lifetime produced a mass of writings so voluminous, is in itself wonderful, but more remarkable is the power of continuous thinking which left its impress upon them all. The striking harmony of thought between Aquinas and Augustine, suggested the fanciful conception that the soul of the African bishop had reappeared after seven centuries in the body of the Italian monk. In him was again seen the union of the highest philosophical power with the most simple and fervent piety, the vigour and acuteness of a master-intellect, with the unearthly humility and devotion of the saint.

The best edition of the works of Aquinas (Rome, 1570–71) is in 17 vols. (18 tom.) folio. These consist of commentaries on Aristotle; commentaries on the Scriptures; the *Summa Theologiæ*, his greatest work, and the most complete and extensive body of theological and moral science ever attempted; his *Summa adversus Gentiles;* and miscellaneous pieces (*Opuscula*). They include also several Latin hymns.

The followers of Aquinas were called *Thomists*. Their fruitless contentions with the *Scotists* or disciples of the great Franciscan Duns Scotus, long divided the schools.

AQUINO, the ancient *Aquinum*, a town and bishop's see of Naples, in Terra di Lavoro. It was one of the chief cities of the Volsci, but has now only 1100 inhabitants. It contains numerous Roman remains, including an amphitheatre and a triumphal arch. Here Juvenal was born; and, according to some, Thomas Aquinas.

AQUINO, *Carlo d'*, an Italian writer, born at Naples in 1654. He was long professor of rhetoric at Rome. His principal works are poems and dictionaries. He translated Dante into Latin verse, but his version has little merit. He died at Rome in 1737.

AQUITANIA, one of Cæsar's great divisions of Gaul. It was not subdued until the reign of Augustus, who extended its limits to the Loire and Cevennes range. In the reign of Honorius it was conquered by the Visigoths, from whom it was wrested by Clovis. Thenceforth it was considered as part of France, until it fell by marriage into the hands of Henry II. of England. It was an apanage of the English monarchs, until Charles VII. finally united it to the French crown, by the capture of Bordeaux in 1452.

ARABESQUE, *Grotesque*, and *Moresque*, are terms applied to paintings and ornaments which consist wholly of foliage, plants, stalks, &c.—the Moors, Arabs, and other Mahometans being forbidden by their religion from making any images or figures of men or animals

ARABIA.

Arabia.

This extensive country, which is situated at the south-western extremity of Asia, has been famed in all ages for freedom and independence; for the peculiar character and manners of its rude tribes; and for the wild and cheerless aspect of its interior deserts, contrasted with the fertility of other tracts, the products of which have always formed the staple articles of the Arabian trade. It has been distinguished in history as the scene of great events, and especially of that wonderful revolution in religion, under the influence of which the Arabs, inflamed with the spirit of proselytism and of conquest, spread their victorious arms over the fairest portions of the earth, and brought about not merely the downfall of empires, but a revolution of opinion and manners which gradually extended over the greater portion of Africa, and over the eastern world from Constantinople to the frontiers of China.

Arabia is a peninsula, stretching north-west and south-east. It has the form of an irregular lozenge, and is inclosed on three sides by the ocean. It is bounded on the south-west and west by the Red Sea and the Isthmus of Suez; on the north-east by the Persian Gulf and the lower course of the Euphrates; on the north-west by Syria, the Euphrates, and the intervening desert; and on the south-east by the Indian Ocean. Its length from this ocean to the frontiers of Syria is about 1400 miles, and its breadth from the Isthmus of Suez to Bassora about 900. The peninsula enlarges in breadth as it approaches the Indian Ocean, and it is greatest in the parallel of Djiddah, viz., about 2250 miles. The division of this country by the ancients was, according to the natural qualities of the soil, into Arabia Petræa, Arabia Deserta, and Arabia Felix. No very distinct boundary was assigned to these divisions. Under Arabia Petræa was included that barren and rocky tract in the north-west of Arabia which is situated between the northern shores of the Red Sea and the Mediterranean, and which may have extended southwards nearly to Mecca. Arabia Deserta was separated from Mesopotamia on the north by the Euphrates; on the west it was bounded by Syria, Judæa, and Arabia Petræa; on the east and south it was separated from Chaldea and Arabia Felix by deserts and mountains. Arabia Felix was bounded on the north by Arabia Petræa and Arabia Deserta, on the south by the Indian Ocean, and on the east and west by the Persian Gulf and the Red Sea. The modern division of the country is entirely different.

Divisions.

The eastern geographers do not agree as to the great divisions of the peninsula and the limits of these divisions. Some speak of two divisions only, namely, Hedjaz and Yemen, but it is self-evident that they do not mean thus to divide the whole of Arabia, but only the western portion of it, or the coast along the Red Sea. Abulfeda mentions five provinces, Tehama, Nedjed, Hedjaz, Yemen, and Arudh or Ared, but this division too is incomplete. The opinion of the Baron von Hammer, who collected and compared a vast amount of geographical evidence from oriental sources, warrants the following as the true great divisions of Arabia. 1. In the north-west *El Hadjr*, literally the "Stony," or Arabia Petræa, with natural boundaries to the east. 2. South of it, *El Hedjaz* along the Red Sea, as far down as about N. Lat. 19°, with natural boundaries, viz., in the east, the table-land of El Nedjed, and in the south, the Tehama of Assyr, that remarkable gap in the great western mountain chain. 3. *El Yemen*, the southern portion of the coast along the Red Sea, extending eastward over a portion of the table-land of southern Nedjed and the low tract El Jof. 4. *El Nedjed*, the upland or high plateau, being the central portion of the peninsula; the tracts bordering on Hedjaz and Yemen are called El Nedjed El Hedjaz, and El Nedjed El Yemen. It is bordered in the south by the great desert *El Ahkaf*. 5. *Hadhramaut*, along the Indian Sea, between Yemen, El Ahkaf and Es Shehr. 6. *Es Shehr*, also called Mahra, because it is inhabited by the tribe Mahra, a dreary tract east of Hadhramaut, which is said to have been changed from a fertile country into a wilderness by the curse of Nebbi Hud, the ante-Mahometan prophet of this part of Arabia. It contains, nevertheless, some well-cultivated and well-inhabited districts. The language of the inhabitants differs very much from the modern Arabic. 7. *El Oman*, the north-eastern projection of South Arabia, at the entrance of the Persian Gulf, and bordering in the south-west on El Ahkaf. 8. *El Hedjer*, or El Bahrein, the coast along the Persian Gulf as far north as the head of the gulf, and bordering in the west on the high plateaux of the interior. It is as frequently, but erroneously, called *Lahsa* or *El Ahsa*, this being the name of a comparatively small district. 9. *El Yemamah*, seems to be the south-eastern portion of El Nedjed. It borders on Hedjer, Oman, and the desert El Ahkaf.

Besides these great divisions, there are others which deserve a short explanation, as they frequently occur in works on Arabia. First among them is *Tehama*. The name designates the narrow belts of sandy lowland between the mountains and the sea; and the whole coast of the Red Sea being of that description, and called accordingly, a belief has sprung up as if the name referred only to that tract. But as there is a Tehama of Hedjaz, so there is one of Yemen, which, however, comprehends some hilly districts; in short, every province bordering on the sea, has its great Tehama; and every district on the coast, or even sea town, has its smaller local Tehama. *El Jof* is the name of a large district to the east of Arabia Petræa, of another one to the east of Yemen towards Hadhramaut, and of several other inland plains; for it is a name in physical geography, meaning a level inland tract lower than the high plateaux, but still higher than the low lands. El Ahkaf signifies a desert characterized by low winding sand-hills, and besides the great El Ahkaf, there are several, and perhaps many, smaller deserts which are distinguished by that name. The great desert between Syria and the head of the Persian Gulf is called Badieh el Arab.

The desert tracts occupy a vast proportion of the soil of Arabia. They consist either of bare rocks, or of hard, loose sand, and are almost destitute of fresh water. Whole years frequently pass away without rain, and the burning sands, reflecting the solar rays, occasion such intense heat as is not felt even in countries that lie directly under the equator. There are no rivers, the mountain torrents being speedily imbibed by the sandy soil; and the scanty supplies afforded by deep wells and springs, scattered at distant intervals, are the sole dependence of the fainting traveller for refreshment, and frequently for life. The aspect of desolation is sometimes relieved by verdant spots, which appear like islands in the trackless ocean; and some rare and hardy plants, such as the tamarind and the acacia, which strike their roots into the clefts of the rocks, find here a congenial soil, and flourish amid the surrounding waste.

Climate. Hot winds.

In the Arabian plains the thermometer is generally above 100° during the night, at 108° in the morning, and in the coolest and shadiest parts in the course of the day it rises to 110°, and sometimes higher. All travellers who have

Arabia. visited the coasts of the Red Sea appear to have been oppressed by the extraordinary heat, and to have considered the temperature of other tropical countries as moderate in comparison. The sultriness of the nights is another peculiar evil of the Arabian climate, and a predisposing cause of disease. For this peculiarity the country is partly indebted to its position, hemmed in between the continents of Asia and Africa, and effectually protected by the latter from the influence of the south-west monsoon, which blows during the summer on the coasts of India, and ushers in the periodical rains: Arabia never experiences the refreshing influence of this wind. It seems to blow exactly along its south-eastern shore, on which prevail baffling winds, or a dead calm.[1] During the whole summer the heat in the lower plains on the coast is so steady and equable that the atmosphere remains in a state of repose. No change of temperature takes place to set the winds in motion; and dead calms occur, and sometimes continue for sixty days without interruption. When the temperature begins to vary with the change of the seasons, and the winds resume their activity, the country is visited by the *simoom* or the hot blast from the deserts, under whose withering influence all nature seems to languish and expire, and which has the quality of extracting from whatever it touches every trace of moisture, and to produce, when it is inhaled by men or animals, a painful feeling, as of suffocation. But though its effects are pernicious to health, they have been greatly exaggerated by credulous or ill-informed travellers; and among others Niebuhr, to whom we are indebted for much valuable information respecting Arabia, ascribes to it the power of suffocating any living creature that is exposed to its influence. Others imagine that it has poisonous qualities. It appears, however, from the accounts of various travellers, and among others of Mr Buckingham, that its effects are produced solely by heat. When it is suddenly inhaled, it may, in the same manner as a hot blast from an oven, cause faintness or sickness, and even swooning; but this feeling is occasioned wholly by the heat and parching qualities which it contracts in its passage across the burning sands. The desert consists in many parts of loose sand, interspersed with sharp and naked rocks; and the effect of these violent winds is to raise up in clouds this fine sand, and to set it afloat in the atmosphere in such quantities that it is impossible to see to the distance of a few yards. On such occasions, during the violence of these sand storms, it is the instinctive practice of camels and other animals to lie down, and bury their nostrils under the sand, to avoid the influence of the wind. In this situation the traveller generally lies down on the lee side of the camel, and in a short time the sand is blown up to the level of the animal, which has accordingly to rise and to lie down on a new foundation, in order to avoid being entirely covered. But in many cases, from weariness, faintness, or sleepiness, occasioned by the great heat, and often from a feeling of despair, both the man and the animal remain on the ground, and in twenty minutes they are buried under a load of sand, and perish miserably in those inhospitable deserts. The approach of the simoom wind is indicated by an unusual redness in the sky, which during the prevalence of the wind seems to be all on fire.

But though a large proportion of Arabia consists of arid and burning deserts, the country immediately behind the dry and sandy plains, which stretches backwards from the seashore, rises into rocky and precipitous hills, with intervening valleys of remarkable fertility. Those mountainous tracts, which send forth ridges into the interior in various directions, enjoy a temperate climate; ice and snow are known at Tayef and Sana, and the Baron von Wrede relates, that on the high plateaux of Hadhramaut the frost is sometimes so intense that the people use axes for breaking up the ice on their reservoirs. All these interior and highland districts are occasionally refreshed by copious rains, though they do not lie within the range of the monsoons, which in the peninsula of Hindustan usher in the rainy season. Those rains occur at different times of the year, according to the position of the mountains. On the western declivity of the mountains of Yemen, along the shore of the Red Sea, they commence in June and terminate in September, which is the season of the monsoons in India. This tract is also refreshed by a spring rain, while on the eastern declivity of the same mountains the season of the rains is between the middle of November and the middle of February. In Hadhramaut and Oman, along the shores of the Indian Ocean and the Persian Gulf, the rainy season lasts from the middle of February to the middle of April; in the highlands of Hadhramaut, transient but frequent thunderstorms, with torrents of rain, mark the months from April to September. The prevailing wind in summer is from the west. The simoom, by which name the Arabs distinguish every hot wind, comes from the east; the south is reckoned favourable to vegetation; while the influence of the north wind, whether it be hot or cold, is always thought to be pernicious to the health both of man and beast. It is occasionally so sultry that it heats metals in the shade as if they were exposed to the sun. On the Persian Gulf the south-east wind is common, and is accompanied with moisture, which, when the heat is intense, occasions violent sweatings, and is even more injurious to health than the hot and dry blast from the northern desert. No traveller has given any accurate measurement of the height of the Arabian mountains; but the decided change of climate which takes place in these upland regions marks a considerable elevation above the adjacent plains.

Soil. Among the Arabian highlands great diversities of soil prevail; and the craggy precipitous form of the hills is unfavourable to fertility. They afford neither sufficient space nor soil for vegetable productions, and the earth is continually washed away by the torrents. In many parts the rocks are basaltic in their form, and so steep that the road ascends by regular steps cut in the rock. These mountainous tracts are in general well cultivated and productive, especially the southern and mountainous provinces of Yemen and Hadhramaut. This was the celebrated region of Arabia Felix, which, contrasted with the adjacent deserts, might deserve that appellation, being a fertile country, yielding the far-famed productions of balm and frankincense, and many sweet-scented trees and shrubs, of which the delicious fragrance, according to the descriptions of poets, was wafted by the winds over the surrounding seas. The mountains of Hedjaz and Yemen, which run along the eastern shore of the Red Sea, are precipitous and often rocky; but water abounds in wells, springs, and rivulets. This entire tract of country is well peopled as far as the mountains which overlook the Indian Ocean, and contains numerous villages of the Arab tribes. In all parts where water is near, and can be artificially spread over the ground, trees and inclosed fields are found; and among the rugged and basaltic mountains extensive and well-watered valleys, which to the south and the east are covered with the herds and flocks of the Bedouin Arabs, and to the north and west, towards the Red Sea, with industrious cultivators, who have relinquished their

[1] It is mentioned by Fraser, in the account which he gives of a *Voyage from Bombay to Mascat*, in the Persian Gulf, that the moment they doubled Cape Rassel Gate, a corruption of Ras-el-Hadd (*ras* means *cape*), and entered the Persian Gulf under the lee of the Arabian land, they were forsaken by the south-west monsoon, and encountered baffling winds or calms until they arrived at Mascat, which is about 120 miles up the Gulf.

vagrant habits, and live in houses. In these valleys, which are frequently separated by intervals of barren rock, and the passes or entrances into which, through the mountains, are so narrow that they scarcely allow two camels to walk abreast, the villages are embellished with gardens, palm-groves, and date-trees, the fruit of which forms in many districts the staple article of the agriculturist; and with extensive plantations of coffee, which, when in flower, exhale an exquisite perfume. In many parts of Yemen whole mountains of basaltic columns are seen, which are rendered subservient to many useful purposes. Being easily separated, and formed into steps, they facilitate the ascent of the heights where it is difficult; and they supply materials for walls to support the plantations of coffee-trees on the steep declivities of the mountains.

The country between the mountains of the Hedjaz and the Red Sea is part of that narrow belt of sand which encircles Arabia. It is called Tehama, the appellation given to all the low plains on the coast, which are generally barren, having fewer fertile spots and more scanty pasturage than the mountains, where rain is more common. Of the regions which are washed by the Indian Ocean and the Persian Gulf we have no full or accurate information. We know, however, that they are skirted by sandy plains similar to those on the western shore. The country which overlooks the Persian Gulf at Mascat has an extremely desolate appearance, consisting merely of sands, and naked rocks blackened by the scorching rays of the sun. It rises into mountains, which may be seen from the sea, and probably attain an elevation of from 1500 to 2000 feet.

Of the provinces of Hadhramaut, Shehr or Mahra, and Oman, more will be said afterwards.

The large province of El Hassa or Bahrein extends along the curve of the Persian Gulf, being in its narrowest part not above 60 miles broad. The coast is a level Tehama, but ridges of hills intersect the interior; and towards Nedjed in the north, and Yemamah in the south, rise the high ranges of Djebel Ared and Djebel Athal, forming the eastern edge of the great table-land of central Arabia. Bahrein is distinguished by its abundance of fresh water, which, although often prevented by the fierce rays of the sun from collecting on the surface, and forming permanent streams, is yet easily to be obtained, even in sandy plains, by digging to the depth of a few feet. Wells are consequently numerous, and enable the natives to cultivate clover, with which they rear a breed of excellent horses. There are many lakes. It appears that here, still more than in any other part of Arabia, the water of the rivers and torrents, flowing down from the higher parts towards the sea, is not entirely absorbed by the sand, but continues its course underneath it, on a substratum of marly clay, the undulations of which it follows according to the pressure it receives from the higher level, giving rise to large bodies of subterranean water. Thence, also, the phenomenon observed along the coast of this tract, of powerful springs of fresh water bursting forth from the bottom of the sea, and easily accessible when the tide is low. At high tides they are sometimes covered with twelve feet of sea water, but so great is their volume and power, that the water remains quite sweet at several feet from the bottom; and, as Captain Skeine relates, divers provided with skin bags will plunge into the salt sea to fetch a supply of fresh water. The fact of powerful salt springs rushing up from the bed of fresh-water rivers, as, for instance, near Kreuznach on the Nahe, in Rhenish Prussia, stands in striking and convincing contradistinction with these fresh-water springs in the Sea of Bahrein. Nor is this phenomenon only of local importance, as is the case with the fresh-water springs at the Giant's Causeway, in Ireland; it bears on, and helps to solve, one of the most important questions relating to the physical geography of Arabia. We allude to the positive statement of Edrisi and other Arabic geographers, that a large river, El Aftan, originating in the interior, traverses the coast, and flows into the Gulf of Bahrein. Yet, when Captain Sadleir crossed and recrossed the supposed line of the Aftan, on his expedition to the camp of Ibrahim Pasha, in 1819, he found no traces of any considerable river; and as the existence of the El Aftan had already been previously denied as being too improbable, it was now set down as a fable altogether. But even suppose he did cross that line, which is by no means certain, although he penetrated as far as Es Sabeh, a village to the south of El Hofhuf, the existence of so much subterranean water, which is of easy access, according to the Captain's own statement—the numerous wells, pools, and even lakes—and last, but not least, the submarine springs of fresh water along the coast, principally about the locality where the Aftan might be supposed to reach the sea,—all these circumstances make it extremely probable that the lower part of the Aftan having been overwhelmed and buried by the sand, the water nevertheless continued to press on upon the clayey substratum, and spreading about in various directions, at last reaches the sea at a level considerably below its surface; when, bursting through the light and sandy bottom, it produces those singular phenomena on the coast of Bahrein. Wellsted entertained such views when he visited the country. There are many other facts bearing upon the existence of a large river in Central Arabia, of which more will be said in the description of Assyr.

The coast of El Bahrein is indicated by a large gulf bearing the same name, extending 80 miles inland, at the mouth of which lies the large island of Bahrein, which is known for the productive pearl fisheries carried on in the gulf. It is a pleasant, well-cultivated island, though once a den of pirates; its capital, Awal or Bahrein, has 5000 inhabitants. On the opposite coast lies the seaport El Katif, with 6000 inhabitants; and in the interior, at a very short distance from each other, are Mubarruz and Hofhuf, said to be peopled, the former by 30,000, and the latter by 40,000 souls, which may have been correct at the time when the Wahabys were powerful in these parts. Quite in the north, not far from the embouchures of the Shat-el-Arab, the united Tigris and Euphrates, lies the small seaport El Kueit or Grane.

Mountains of Arabia.

It has already been observed that, with the exception of Arabia Petræa, the whole northern part of the peninsula is a comparatively low plain, intersected by ridges of hills of little elevation. It extends south as far as north latitude 28°. There the Djebel Shammar rises abruptly, a lofty range traversing the interior in a direction from west to east, and visible at a great distance. The Arabs say that its central portion, or Djebel Shammar, properly speaking is as high as Mount Lebanon, or about 9000 feet. The great hadj and caravan roads from Damascus and Baghdad to the holy cities and the inland of Nedjed traverse this vast and arid district, but our knowledge of it is still very imperfect. Dr Wallin, professor in the university of Helsingfors, in Finnland, explored the tract a few years ago, starting from the Gulf of Akaba, and thence proceeding to the foot of Djebel Shammar, whence he returned by the road to the Tigris. He was the first known European who ever proceeded so far in that direction, but his account in the Journal of the Royal Geographical Society of London, is of more importance to the linguist and antiquarian than the geographer. Along the Derb Bereidha, or hadj road from Baghdad, there are numerous deep and very carefully constructed wells, among which that of Wakiyeh, which was built by order of Melek Shah, Sultan of the Seldjuks in Persia, is said to be 800 feet deep by 10 wide. Several wells have been constructed by Sobeidah, the wife of the great Khalif Harun-al-Rashid.

The entire extent of Arabia south of Djebel Shammar is an elevated table-land, resembling a barren rocky crust raised by subterranean power. Ridges of varying elevation rise above it in a direction from west to east, and it is rent asunder in all parts by deep gaps forming narrow *wadis* or valleys flanked by bare, precipitous rocks. These are the only localities containing a settled population, being watered by temporary or permanent streams which render the soil fit for cultivation. Nearly all the towns are situated in such wadis, as far instance Derraiyeh, the once flourishing capital of the Wahabys. Large tracts, however, are considerably lower than the general level of the table-land, and being

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covered with moveable sand, which has filled up the gaps by which the rocky substratum is cut up, form the most dangerous among all the deserts of Arabia. The great wilderness, and the smaller ones, called El Ahkaf, belong to this description. It appears that a broad but high plain or valley, beginning in the west at the foot of the mountains of Assyr and sloping down towards the Persian Gulf, bisects that immense table-land into a northern and a southern portion. This tract was never visited by Europeans, but eastern geographers inform us that it constitutes the best part of the great province of Yemamah: it is well watered and produces an abundance of corn and fruit. The eastern less frequented caravan road from Mecca to Baghdad crosses it in a direction from south-west to east and north, touching or passing near the village El Hauta, which, according to Burckhardt, is the birthplace of the famous Abd-el-Wahhab, the founder of the sect of the Wahabys. The principal mountain chain which overlooks the table-land is Djebel Imariyeh or El Ared. From the Alpine highlands near Tayef, it stretches north-east as far as Derraiyeh, falling off in the north like a stupendous wall of white rock, whence we may infer that it is of limestone formation. From that town it continues in a more northern direction almost parallel to, but still distant from, the Persian Gulf, and forming the natural boundaries between Nedjed and Hedjer or El Bahrein. From its central portion near Derraiyeh another chain runs north by west under the name of Djebel Tueik which seems to join the latitudinal chain of Es Shammar in its very centre, which, on account of its serrated appearance is commonly called El Djebel. Between the chains of Ared and Tueik lies the district of Sodaïr; west of Mount Tueik are the districts of Kasim and Woshem; and to the south-east of Derraiyeh is the smaller one of Khardj. The environs of Derraiyeh are full of once thriving towns, situated in narrow rocky wadis or glens, but since the last successful invasion of the Egyptians they are in ruins. To the south of Western Yemamah, and parallel with Djebel Imariyeh, but at a distance of 200 miles from it, a chain of high mountains has been observed in a north-east direction, which seems to be the Djebel Menakib of the Arab writers. There is reason to believe that there are many more inland chains, but we know nothing positive about them.

In proportion as the arid and elevated interior of Arabia approaches the sea, it begins to lose the peculiar features of a high table-land. Almost everywhere its descent towards the lower level presents several terraces, the serrated edges of which form as many chains of mountains. On approaching the peninsula from the seaside, it first seems as if there were but one such edge, but on surmounting the first, the traveller soon meets another, and in many localities a third and a fourth one; and although the ascent is not always steep, the increasing difference of temperature indicates a higher level. The lower edge of the table-land towards Hedjaz is commonly called Djebel-el-Hedjaz, of which the section between north latitude 25° and 23° bears the name of Djebel Raduah, and is about 6000 feet high. East of it lies the holy city of Medinah, on the third terrace, and consequently at a considerable elevation, and perhaps as high as from 4000 to 5000 feet above the sea. Between Mecca and Tayef, the chain bears the name of Djebel Kora, of which M. Gazuan is not only the highest portion, but probably the highest peak in Arabia, if it be true that its summit is covered with snow even in summer, which would give it an altitude of about 14,000 feet. But this is very questionable. It has already been observed that in north latitude 19°, a remarkable gap, the Temanah, or perhaps Tehama of Assyr, affords an easy communication between the coast and the interior, being, at the same time, the natural boundary between Hedjaz and Yemen. The extensive chain from that great defile down to the Straits of Babelmandeb is called Djebel-el-Yemen, and the southern portion simply El Djebel, on account of its many peaks and serrated aspect. It appears to reach an altitude of 9000 feet, and in the latitude of Sana, swells out into a broad mountainous tract sloping down abruptly towards the district El Jof, and the sandy plains of Mareb. The town of Sana, the capital of the dominions of the imam or sultan of Sana, to whom all Yemen is either directly or indirectly subject, lies 5000 feet above the sea, the surrounding peaks rising to from 2000 to 4000 feet above that high plain. Numerous torrents flowing in deep valleys between high precipitous rocks, water this interesting tract, but in the dry season they dwindle into streamlets. In the arid tehamas they dry up entirely, at least near the surface, because at the depth of a few feet below the burning sand, water is always obtainable by digging, except in years of total drought.

Irrigation.

In few parts of Arabia is the system of irrigation brought to such perfection as in the highlands of Yemen. Water is superabundant in the rainy season, but the rapid descent of the torrents causes it to vanish as fast as it fills the glens to overflowing; and in the dry season, the hot rarified air absorbs it in such a degree as to lay all water-courses dry. Deep wells and reservoirs, together with tanks and cisterns of every description, thus become a matter of necessity; and it is owing to the surprising care bestowed upon such works, that the coffee plantations are in so luxuriant a condition. As long as the lower reservoirs, which, however, are still higher than the respective terraces for the irrigation of which they are constructed, yield a supply, those on a higher level are not only spared, but still fed if possible; but in proportion as the former become exhausted, the latter are opened; and the water descending through covered conduits again fills those which are nearest to the plantations. On the drying up of these, also, the deep wells in the shady glens are resorted to, and the water is carried up the hills in skin bags on the backs of donkeys. The inhabitants themselves will lend their backs to this drudgery to save their crops. Around the stem of each coffee-tree, pebbles are heaped up, which serve the double end of preventing the roots from being laid bare by torrents, and of keeping the soil moist in the dry season.

Vegetable produce.

Arabia, from its diversified surface, contains within its bounds the climates and the vegetable produce of different countries. The mountainous tracts yield in great abundance wheat, barley, and an inferior species of grain called *durra*; also the fruits of Europe in equal variety and perfection, such as figs, apricots, peaches, apples, almonds, pomegranates, grapes of the very best quality, and excellent dates, which in many parts are the chief food of the inhabitants, as well as an article of export. Many of the fine fruits of India have been transported thither, and are now naturalized. Such are the banana tree, the mangoustan, the Indian palm, and the Indian fig-tree. Besides the European grains it yields abundantly rice and maize. In the highland provinces forests are sometimes seen, which contain many trees little known, or differing extremely from the same genera in northern countries. The tamarind-tree refreshes and embellishes the country by its agreeable shade and elegant form. The balm-tree is peculiar to Arabia, which is also the native country of the coffee-tree, though, according to the Arabians, it comes originally from Abyssinia. The balm-tree has not a beautiful appearance, and its qualities are not appreciated in the southern province of Yemen, where its wood is burnt for a perfume. In the Hedjaz the inhabitants collect the balsam and bring it to Mecca: it is thence exported to Turkey, where it is in high estimation. The tree from which incense distils is found in part of Hadhramaut, along the shores of the Indian Ocean. Arabia has been in all ages celebrated for sweet-scented shrubs and trees; and Burckhardt mentions, that one morning at sunrise, when he was on his road from Tayef to Mecca, every tree and shrub exhaled a delicious fragrance. There are various species of the sensitive plant, of which the splendid flowers, of a beautiful red, are formed into crowns for festive occasions. The sugar-cane and the indigo-shrub are found in different provinces; and the shrub from which senna is produced is cultivated in all that part of the country which lies opposite to Upper Egypt. The Arabians cultivate garden vegetables, such as lettuce, carrots,

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radishes, water-cresses, and a great variety of gourds, cucumbers, pumpkins, and melons. The melon is in such variety and abundance that, for a part of the year, it constitutes an article of food. Many plants and herbs which have been brought from India are now naturalized in the country; and there is abundance of indigenous plants, noted for the beauty of their flowers and their fragrant smell. The gardens at Tayef, among the mountains, 72 miles east of Mecca, are renowned for roses of such exquisite beauty and fragrance, that they are sent to all parts of the country. The soil of the desert, though sandy, yields a variety of herbs, which constitute the food of cattle; and every district has a peculiar plant, which will grow in no other part. These herbs grow to the height of three, and some of them of six feet; and when they are withered by the sun they are eagerly devoured by the camel.[1]

Coffee-tree.

The celebrated coffee plantations of Yemen occupy the slopes of these valleys, rising in terraces one above the other, to a height of about 3000 feet above the sea, beyond which point the cultivation of the tree ceases to be profitable, or becomes impossible. A large proportion of the choice product, which is known in Europe under the name of Mokha coffee, because most of it is exported from Mokha, grows on those terraces; but as much is imported from the opposite coast of Africa, and, being exported again, is sold in Europe under the same name. The finest coffee is said to grow in El Ghamid, a small district in north latitude 20°. The inhabitants of Yemen, even the wealthier, seldom use the coffee-bean (*boon*), but only the *Keshir*, or the husk, in which it lies; the bean being sold at Mokha and Djidda for exportation. The beverage also, which is obtained from the roasted husks by an infusion of boiling water, goes by the name of Keshir, and coffee-houses or *Keshir eshes*, that is, *huts*, are everywhere to be found, even along the roadside, for the accommodation of travellers. Many of these establishments are pious institutions, where the wayfarer is gratuitously accommodated, for three days, with lodging, keshir, and durra. Another similar beverage is obtained from the fleshy part of the berry; and this is sometimes called *cawa*, whence our *coffee*. According to the universal statement of the natives, the coffee-tree was first brought over from Africa, and cultivated in Yemen, in the fourteenth century of our era, by a holy man named Shadeli, who is still revered by the Arabs as a benefactor of mankind, so much so that they never raise a cup of coffee, or keshir, to their lips without previously praising his name in a short prayer. Modern travellers have confirmed the fact, that the original home of the coffee-tree is in the high, mountainous country to the south of Abyssinia; but while some report that the district of Kaffa is not only its cradle, but has also lent its name to the tree, others, among whom that eminent investigator, Dr Beke, contend that no coffee grows in Kaffa. However this may be, the inland town of Hurrur, which lies to the east of Kaffa, is a chief market for African coffee.

Kaat is also extensively cultivated and consumed in Yemen. It is a small tree or shrub, the leaves of which resemble those of the willow, and, when dried, taste somewhat like tea. The Arabs chew it because it exhilarates the mind, keeps people awake, and makes them talkative, whence it is now in high estimation among so social and garrulous a nation as the Yemenites are. The taste of the young leaves is a delicious mixture of sweet and bitter, the former prevailing; so much so, that water drank after it tastes like scented lemonade. The rich use the young leaves with the morning dew still upon them, and this makes them dear, as they are gathered at some distance from the towns. Wealthy Yemenites will chew from two to three crowns' worth of Kaat in one day. Dr Beke brought some well-preserved sprigs with him from Abyssinia, where it also grows, which the writer of this was kindly allowed to examine and taste.

Animals.

The wild animals of Arabia, which are principally found in the mountains, are the panther, sometimes mistaken for the tiger, the ounce, the hyena, the wolf, the fox, a species of wild dog of a black colour, common in many countries in the East, the wild cat, the jackal, the wild ox, and monkeys in great numbers. In the sandy tracts is found that curiously constructed animal the jerboa. The wild boars are very numerous, but not in the heart of the desert. The Arabs who live at Tadmor in Northern Arabia are famous for their dexterity in killing them with the lance. The beautiful and timid gazelle is found all over the Arabian desert. On the eastern frontiers of Syria there are several places allotted for the hunting of these animals, which are taken by hundreds. There are several sorts of lizards, and the land-tortoise is common, being brought by the peasants in cart-loads to the markets of many towns in the East. The domestic animals are the horse, the ass, the camel, and the ox.

Horses.

The Arabian horse has been justly renowned in all ages of the world for all the finest qualities, namely, swiftness, patience of fatigue, spirit, and docility of temper; and it is from the Arabian breed that the European horses derive all their most valuable properties. The best horses are found in the greatest numbers in the luxuriant pastures of Mesopotamia, the banks of the Euphrates, and in the Syrian plains. In Nedjed the horses are also of a very fine quality, though they are not so numerous as in these countries; and they are still more scarce in the southern provinces of Yemen, Oman, and Hadhramaut, on the shores of the Indian Ocean, owing to the great heat of the climate; nor are the mountainous regions of the Hedjaz favourable to the rearing of this fine animal. There are not, according to Burckhardt, more than 6000 horses in the whole western country of Arabia, from the northern point of Akaba on the Red Sea to the southern coasts, comprising the great chain of mountains and the western plains. The provinces of Yemen, Hadhramaut, and Oman, are also supplied with horses from the pastures of Nedjed.

In the wars and inroads of the desert, the Arab soldier, whether he is pursuing, or flying for his life over the naked plain, wholly relies on the quality of his horse. On this account they spare no pains in rearing their horses and in preserving the purity of the breed. The birth of every noble foal is ascertained by the presence of eye-witnesses, and a written certificate is made out of its distinctive marks, with the names of its sire and dam, which is wrapt in a small piece of leather covered with wax-cloth, and is hung round the animal's neck as the standard and evidence of its value. The genealogical table never ascends to the granddam, because every Arab knows by tradition the purity of the whole breed; and there are many horses and mares of which the noble descent is of such notoriety throughout the tribes, that no written evidence of the fact is required. The Arabs reckon five noble breeds of horses, whose lineal descent they assert to be from the five favourite mares of the prophet. But as all the collateral branches claim the same illustrious ancestry, there is an infinite variety of noble breeds in the desert; and every mare which is particularly handsome, and belonging to any of the five chief races, may give rise to a new breed, the descendants of which bear her original name. Those pastoral tribes, when a foal is born, receive it in their arms, and so cherish it for several hours, stretching its tender limbs, and caressing it as if it were a child; and when it is placed on the ground, they watch its feeble steps, prognosticating its future excellencies or defects. The colt is mounted after its second year, after which it is fed upon barley, which is the usual provender throughout Arabia, though in Nedjed the horses are regularly fed on dates; and the wealthy inhabitants give them flesh, raw as well as boiled, and all the fragments of their own meals. In other respects they are hardly treated. They remain in the open air during the whole year, with the saddle constantly on their backs, and are not even taken under the shelter of the

[1] Burckhardt's *Travels in Arabia*, vol. ii. Appendix.

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tent in the rainy season, or during the heat of the mid-day sun; yet with all this treatment they are seldom ill. The Arabs never clean or rub their horses; but they are careful to walk them about gently on their return from a ride. They prefer mares for riding, on account of their more patient endurance of fatigue, hunger, and thirst, than horses, and because they are gentler and less vicious, and never neigh when they are lying in ambush to surprise passengers. According to Burckhardt, the finest race of Arabian blood horses may be found in Syria; and of all the Syrian districts the breed in the Hauran is the best. But all the horses of the noble breed are not equally distinguished. Among these there are only a few, perhaps not above five or six in a whole tribe, of the first-rate class in respect to size, bone, beauty, and action. In the whole extent of the Syrian deserts there are not, according to the estimate of this traveller, more than 200, worth, even in the desert itself, about L.150 or L.200 each; and of these very few, if any, have ever found their way to Europe, although many horses of second and third-rate quality from Syria, Barbary, and Egypt, have been imported into England, and have passed for the pure Arabian breed. The price of horses in Syria is from L.10 to L.120. An Arab mare cannot be obtained under L.60: a celebrated mare will often bring from L.200 to L.500. A mare is frequently the joint stock of two, three, four, or any greater number of proprietors; and when she has foaled, the colt is sold, and the price is divided among the proprietors. Burckhardt mentions a scheik who had a Nedjed mare, for the half of whose belly, according to the phraseology of the Arab market, he paid L.400. D'Arvieux mentions an emir who "had a mare that he would not part with for 5000 crowns, because she had travelled three days and three nights without drawing bit, and by that means got him clear off from those that pursued him." A similar anecdote is told of a troop of Druses, who, having attacked an Arab encampment, were assailed by a superior force, and all killed except one man, who fled, and was pursued by some of the best mounted Bedouins. "But his mare, although fatigued, continued her speed for several hours, and could not be overtaken. Before the pursuers gave up the chase, they cried out to the fugitive, promising him quarter and safe-conduct, and begging him that he would allow them to kiss the forehead of his excellent mare. Upon his refusal they desisted from pursuing, and, blessing the generous creature, they exclaimed, addressing her owner, "Go and wash the feet of your mare, and drink up the water;" a phrase by which the Bedouins express their sense of the invaluable services rendered by those fine animals.[1] The Arabs treat the mares which they keep for riding with invariable tenderness. They never beat them, but make much of them, reason with them, talk with them, and take all imaginable care of them. They never spur them, except in cases of peculiar urgency, when the generous animal flies over the plains with so rapid a motion that the rider is apt to be stunned. Many curious instances are given by travellers of the care and affection with which the Arabs treat their horses. An affecting anecdote is related of an Arab, who having sold the half of a mare renowned for beauty and other fine qualities, for 1200 crowns, made frequent journeys to inquire after her welfare. "I have many a time," says D'Arvieux, "had the pleasure to see him cry with tenderness, whilst he was kissing and caressing her. He would embrace her, would wipe her eyes with his handkerchief, would rub her with his shirt-sleeves, would give her a thousand blessings during whole hours that he would be talking with her. 'My eyes,' would he say to her, 'my soul, my heart, must I be so unfortunate as to have thee sold to so many masters, and not to keep thee myself? I am poor, my Antelope; I have brought thee up like a child; I never beat nor chid thee. God preserve thee, my dearest; thou art pretty, thou art sweet, thou art lovely; God defend thee from the looks of the envious!' He then embraced her, kissed her eyes, and went backwards, bidding her the most tender adieus. Another Arab, who had sold his mare and put the money in the bag, looked wistfully on the animal, and began to weep. 'Shall it be possible,' said he, 'that, after having bred thee up in my house with so much care, and had so much service from thee, I should be delivering thee up in slavery to the Franks for thy reward!' on which he threw down the money on the table, embraced and kissed the mare, and took her back to his tent."[2]

Camels.

The camel is an invaluable animal in Arabia, being peculiarly qualified, by its power of enduring thirst and fatigue, for traversing its burning plains. The camels of the Arabian and Syrian deserts are of a smaller make than those of Anatolia or Kurdistan and other northern countries, and they have only one hump. They are used either for the purposes of riding, or for carrying heavy burdens. The smaller and more active camels, or dromedaries as they are termed, or in Arabia *deloul*, which are used for riding, are the same race as the heavier camels, which are employed in carrying burdens, being merely distinguished as a hunter is from a coach-horse. The common load of an Arabian camel is from 400 to 500 pounds on a short journey, and from 300 to 400 pounds when the distance is greater. The Egyptian camel, which is equal in strength to the Anatolian, will carry a load of three bales of coffee, equal to 1500 pounds, from Cairo to the water-side, a distance of three miles. The dromedary, or the riding camel, is used in travelling, though in speed it is far surpassed by the horse. Incredible stories are told of the wonderful expeditions performed by these animals. Burckhardt was assured by a Bedouin that his grandfather made a journey on a camel of 250 miles in one day; and he himself mentions that, on a wager, a camel was engaged to go in one day, between sunrise and sunset, a space of 125 miles; and actually travelled in 11 hours 115 miles, when its strength failed. The rate of speed at which a camel goes, even on a gallop, which is not his natural pace, and cannot be maintained above half an hour, is never more than 16 or 18 miles in the hour. In trotting, 12 miles an hour is the utmost limit of his speed, which may be continued for several hours. But a camel will carry his riders without interruption for several days and nights, in an easy and gentle amble, the favourite pace, at the rate of about 5 or 5½ miles in the hour, and will travel for five or six days 10 or 11 hours each day. A sort of palanquin is fixed on the backs of these camels for women, in which they are concealed from the public eye, and may stretch themselves at full length. The capacity of bearing thirst varies considerably in the different races. The Arabian camel must be watered on the evening of every fourth day. Some animals, though they may go five days without drinking, cannot be safely exposed to such a trial. The caravan routes are never at a greater distance than three or three and a half days' journey from water; but the caravans from Arabia to Egypt travel, during the heat of summer, through deserts in which water is wanting, for nine or ten days; and though many camels perish, the greater number come safely to Egypt. The Turcomans

[1] Burckhardt's *Notes on the Bedouins and Wahabys*.

[2] D'Arvieux, chap. xi.

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and Kurds purchase every year from 8000 to 10,000 camels in the Syrian deserts, of which the greater part are brought originally from Nedjed. The price of a camel varies almost in every place. In Hedjaz a common riding camel may be bought for 50 or 60 dollars, and for some of the first quality 200 and even 300 dollars are sometimes paid.

The wild ass is found in great numbers in the country adjoining the district of Djof, to the west of Djebel Shammar, between Tobeck, Sauan, and Hedrush, and to the south of those places. It is hunted by the Arab tribes, who eat its flesh, and sell its skin and hoofs to the pedlars of Damascus and to the people of Hauran. Out of the hoofs rings are made, which are worn by the peasants as a charm against rheumatism. The domesticated ass in Arabia, as in all the other countries of the East, is a strong, active, and spirited creature, the rival of the horse in utility, if not in beauty. It retains all the strength, swiftness, and fire of the wild animal.[1] Arabia is not famous for horned cattle. The cow is used, however, in many places, for drawing water from the wells, and other purposes. It is small, and of a stout, bony make, with short stumps of horns, and a hump on the back over the shoulder, like the cows on the Nile and in Nubia.[2] The northern tribes of Arabia, namely, the Aenezes, and the Ahl el Shemal, possess abundance of goats and sheep. The goats are mostly black, with long ears. The sheep have not the fat tails of those that are found in some countries; their ears are rather longer than those of the common English breed. The Arabs use in their families the milk of their flocks. They also make great quantities of butter, part of which they sell to the peasants and town's people.

Birds.

Arabia produces a considerable variety of birds. In the fertile provinces tame fowls abound, and all sorts of poultry. The pintado inhabits the woods in such numbers that children kill them with stones and collect them to be sold in the towns. In the forests of Yemen pheasants abound; also the wood-pigeon, and other varieties of the same species. In the plains is found the gray partridge, the common lark, the wild goose, and a species of white crane having the under part of the belly of a beautiful red. Eagles, falcons, sparrow-hawks, and the Egyptian vulture, are the Arabian birds of prey. The last clears the country of all carrion, and also of field mice, which multiply prodigiously in some provinces. There is another bird of prey, of the thrush species, which is equally useful in pursuing and destroying the swarms of locusts with which the country is infested. There are various birds which are little known, and which are supposed to be birds of passage from India, distinguished by peculiar brilliancy of plumage. There is one which has two large and beautiful feathers, with which the Arabians adorn their caps; and another which, for its rare beauty, is sold for a high price. A beautiful lapwing is common on the shores of the Persian Gulf. The sandy tracts of the desert abound in ostriches: these are hunted by the Arabs for their feathers, which form a valuable article of trade. The ostrich inhabits both the great southern and northern deserts. They abound in the plain extending from Hauran towards the central provinces of Djebel Shammar and Nedjed. Some are seen in Hauran, and a few are taken almost every year within two days' journey of Damascus. They generally breed in the winter, and the Arabs discovering the nest, scare away the birds, when they resort to the following contrivance for destroying them:—A hole is dug in the ground near the eggs, into which the Arab places a loaded gun, with a long burning match fastened to the lock. The ostriches resume their place generally both at once on the eggs: in due time the gun is discharged, and next morning the Arabs find one or both of the ostriches laid dead beside the eggs. The feathers are sold at from L.2. 6s. to L.2. 10s. per pound, and the finest at from one to two shillings each. In places where there is water, plovers and storks abound; and sea-fowls, feeding on fish, are numerous on the coasts of the Red Sea, which is deep, and copiously stored with their food. Here, and on the isles along the shore, the pelican is to be found.

The heat of the climate favours the breed of serpents, some of which only are dangerous, while others are perfectly harmless. The only one that is truly formidable is a small slender creature, with black and white spots, whose bite is followed by instant death, and an extraordinary swelling of the body from the malignity of the poison. Of the insects in Arabia, the most remarkable as well as the most destructive is the locust, which flies in swarms that darken the air, and with a frightful and stunning noise, such as is made by a water-fall. The fields are entirely despoiled of their verdure by these insects. The pulse and the date trees are also greatly injured; but the corn, when it is nearly ripe, resists, by its hardness, their attacks. Locusts are found in all parts of the Arabian deserts. They come invariably from the East,—from the waters of the Persian Gulf, according to the notions of the rude Arabs. In the central province of Nedjed they not only destroy the produce of the fields, but penetrate by thousands into private dwellings, where they devour whatever they can find, even to the leather of the water-vessels. In the peninsula of Sinai the inhabitants are driven to despair by swarms of locusts, which consume the fruits of the earth. All the Arab tribes, as well as the inhabitants of towns, are accustomed to eat this insect; and at Medina and Tayf there are shops in which they are sold by measure. After being salted, whole sacks are filled with them. The destructive insect the white ant, which preys upon victuals, clothes, furniture, and the leaves of trees, is common. There is another ant, whose bite is like that of the scorpion, although it is not dangerous. The scolopendra affects those whom it attacks with burning pains. It fixes its feet so firmly in the flesh that it cannot be got out but by burning the part with a hot iron. Other insects destroy reeds and stalks of corn, and make their way into houses. There are many species of crabs, some of them peculiar to the Red Sea, which are excellent, and, but for the peculiar aversion of the Mussulmans to shell-fish, would afford a wholesome subsistence. At Suez they form almost the sole food of the Copts.

Minerals.

Arabia has never been noted for its minerals. It was supposed by the ancients, who had the most exaggerated ideas of its wealth and produce, to abound in precious stones, as well as gold and silver. Except it be the onyx, which is found in Yemen, and the carnelian, it produces no other stones of value; iron ore seems to be abundant in parts of Yemen, and indications of many other minerals have been found in Hadhramaut. There are mines of fossil salt among the mountains, which were formerly worked, but are now neglected; and the iron of Yemen is found to be of a coarse quality and brittle. In Oman are very rich lead mines, the produce of which is largely exported from the harbour of Mascat, in the Persian Gulf.

Arab tribes.

Burckhardt, whose posthumous work[3] contains the most ample and satisfactory details of Arabian manners, gives a

[1] Niebuhr, vol. ii. chap. iii. Burckhardt's *Notes on the Bedouins and Wahabys.*

[2] Burckhardt's *Travels in Arabia*, p. 127

[3] *Notes on the Bedouins and Wahabys.*

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particular classification of the Bedouin tribes. Those who inhabit northern Arabia he distinguishes into two classes; namely, the Aenezes, who migrate with the spring and summer to the fertile parts of Syria, and return with the winter to the desert; and others, who remain the whole year in the vicinity of the cultivated tracts. The Aenezes, reckoning their brethren in Nedjed, form one of the most powerful associations of shepherds in the Arabian deserts. They levy contributions on the Syrian villages, as well as on the pilgrim caravan in its passage from the desert to Mecca; and their numbers are estimated at from 300,000 to 350,000, and their military force at 10,000 horsemen, and from 90,000 to 100,000 camel-riders.

There are numerous other tribes in northern Arabia, scattered along the frontiers of Syria and the banks of the Euphrates. They are not so migratory in their habits as the Aenezes, with whom several of them carry on the most deadly strife, while others pay a yearly tribute to all the chief Aeneze tribes, and in some cases to the pacha of Damascus. Many of them cultivate the land though they dwell in tents; and those on the borders of Syria carry their produce of milk, butter, and cheese to the market of Aleppo. There are other tribes that range over the country to the south, over the mountains that run in a direction parallel to the Red Sea as far as Medina and Mecca, or in the interior plains and mountains of Djebel Shammar, Kasym, and Nedjed. Some of those tribes, as the Beni Shammar, can muster from 3000 to 4000 men, armed with matchlocks; others, such as Meteyr, who occupy the fruitful pastures of Nedjed, 1200 horse, and from 6000 to 8000 matchlocks. The country from Kasym towards Medina and Mecca, and the coast southward from Yembo to Djidda and Leith, for about 250 miles, is inhabited by the Beni Harb, which, next to the Aenezes, is the most powerful tribe in Arabia. They can muster from 30,000 to 40,000 men, armed with matchlocks. The Harbs are partly settlers and partly Bedouins. They may be styled the masters of the Hedjaz, and were the last tribe in those countries that yielded to the Wahaby arms. They take a yearly tribute from the Egyptian and Syrian caravans; and they extend their predatory inroads against the encampments of the Aenezes to the vicinity of Damascus. On the sea coast, where the territory is poor, they derive a subsistence from fishing; and many of them are sailors, and act as pilots between Yembo and Djidda. But these tribes, from their intercourse with the inhabitants of towns, and their maritime habits, are regarded with disdain by the genuine Arabs. To the east of Mecca and Tayf, in the fruitful pastures of the interior, resides the brave and powerful tribe of Ateybe, the inveterate enemies of the Beni Harb, who can muster a force of 10,000 matchlocks. In the neighbourhood of Mecca are many well-known tribes, now reduced to about 250 or 300 matchlocks. The tribe of Koreish, so famous in the Arabian annals, who encamp near Mount Arafat, now amount only to 300 matchlock-men. The tribe of Adouan, which 40 years ago mustered about 1000 matchlocks, and were celebrated all over Arabia for their valour and hospitality, are now reduced to 100 families. It is to this tribe that the reigning sherifs of Mecca send their children to be educated. In the mountainous region between Mecca and Tayf reside the warlike tribes of the Hodheyl, mustering 1000 matchlocks, famed as excellent marksmen, brave soldiers, and daring high-way robbers; the Toweyrek, who muster 500 matchlocks, and have the character of dexterous thieves; and the Thekyf, who possess the garden country around Tayf, and the other equally fertile valleys on the eastern declivity of the great Hedjaz chain of mountains. The wealth of these mountain tribes consists in flocks of sheep and goats. They suffered severely, especially the Hodheyl, in their obstinate but unavailing resistance to the Wahabys. From Tayf southward, along the eastern face of the great chain of mountains to Sana, are several ancient and powerful tribes, renowned in Arabian history. Some are partly cultivators and partly Bedouins. The Beni Kahtan and the Beni Sad are famous from the most remote antiquity. The former is exclusively pastoral, abounding in camels above any other tribe of the desert. Some of these southern tribes can muster from 500 to 1500 matchlocks. They are brave and warlike, and they extend from the mountains over the eastern and western plains. The tribe of Asyr can assemble 15,000 men, armed with matchlocks. Of the various tribes scattered over the mountains of El Shehr or Mahra, and the countries that are washed by the Persian Gulf, we have no detailed or accurate accounts. The tribes in the mountains are, however, in general employed in agriculture; many of them live in tents, and descend in spring into the neighbouring plains for pasture to their flocks. The cultivators dispose of their produce, which is abundant, in the towns on the coast.

Manners and character of the Arabs.

Arabia has been celebrated from time immemorial as the seat of independence and of pastoral simplicity, and it is perhaps the only country in the world which, until it was lately overrun by the troops of Mohammed Ali, was never profaned by foreign conquest. Mountains and deserts, as is well observed by Sir John Malcolm,[1] have been in all ages the sanctuaries of the brave and the free; and thither the hardy Arabs, when pressed by powerful armies, have always fled to enjoy freedom and independence. On the sea coasts and in the towns the Arab character has been corrupted by commerce and a free intercourse with foreigners; but in those secure recesses the ancient manners of the country are still to be found. The genuine inhabitants of the desert unite the character of shepherds and soldiers. They live in tents, and they subsist by maintaining flocks of sheep and camels, and also cows and horses. The larger tribes are chiefly employed in rearing camels, which they either sell to their neighbours, or employ in the carriage of goods or in military expeditions. The petty tribes maintain flocks of sheep. They disdain the cultivation of the ground, as an employment degrading to a pure Arab, and which they accordingly leave to the inferior race of peasantry and slaves. These Bedouins live the usual vagrant life of shepherds, emigrating from one place to another with the change of the seasons, in quest of pasturage, and transporting their dwellings along with them; so that a village arises often in a situation where, an hour before, not a hut was to be seen. The genuine Arabs, who live constantly in the open air, acquire a remarkable acuteness in all their senses. Their powers of vision and of hearing improve by constant exercise; and on the vast plains of the desert objects invisible to a less practised eye are at once seen by them. Their sense of smelling is extremely acute; and their dislike to a town life is occasioned by the nauseous exhalations which are produced among such a dense collection of people. The Arabs possess the same faculty of nicely distinguishing on the sand the footsteps of men and beasts which the American Indians distinguish on the grass. To such perfection have they arrived in this art, that an Arab will at once recognise the footstep of any one of his own or of some neighbouring tribe; he will know

[1] *History of Persia.*

whether the person carried a load; whether he passed the same day, or a day or two before; whether, from a certain irregularity in the steps, he was fatigued, had come from a distance, and how far he has any chance of overtaking him. He knows at once the footsteps of his own camel—whether it was heavily loaded, or mounted only by one or more persons. A keen Arab guide has his eye constantly on the footsteps which he sees; and Burckhardt mentions that he has seen a man discover and trace the footsteps of his camel amid thousands of other footsteps crossing the road in every direction, and, by an inspection of the footsteps, tell the name of every person who had passed there in the course of the morning. Many secret robberies are brought to light by this power of nice observation. Instances have been known of stolen camels found after a journey of six days; and so long as the traces of men or camels can be seen on the sand by the practised Arab's discriminating eye, robberies are almost sure of detection. So thoroughly are the Bedouins inured to fatigue and the want of water, that they will wander about five days without tasting it, and will at last discover a pit of water by examining the soil and plants in the environs. They ride on horses and camels, and are continually armed with a lance, a sabre, and sometimes a matchlock or a pistol. Some of them wear coats of mail. All those wandering shepherds are addicted to violence, and to the fierce habits of a military life. They are either engaged in open war about their wells or pasture grounds, or in plundering excursions or secret robberies, which they do not consider to be in any degree criminal; and no more flattering title can be conferred on an Arabian youth than that of robber. The defenceless traveller, whom they descry from afar on the level plain, is marked out for their prey. He is seized, stript of every thing, and left naked in the desert. If he resists, and more especially if he sheds the blood of a Bedouin, they take his life. But the Arab plunders sometimes strangers and neighbours, enemies and friends, provided they are not actually in his own tent; in general, thieves convicted of robbery against a fellow clansman are expelled from their tribe and outlawed, a punishment which they fear more than death. Associations are frequently formed for the plunder of caravans, or of the cultivators who dwell in villages, whose cattle they carry off, and sometimes, though very rarely, their young women. In those cases they proceed with a considerable force. Their chief object, however, being still plunder, the great point of Arab tactics is to surprise the enemy's encampment, and to carry off the cattle and the camels. They seldom engage in any sanguinary conflicts; for though the Arab, in facing the enemies of his country, behaves like a brave soldier, he is a mere poltroon in his plundering expeditions; and the caravan travellers and peasants frequently put to flight three times their own number of those wandering robbers. In undertaking an expedition for plunder at the distance of ten or twenty days' journey, every horseman who is of the party chooses a companion, who is mounted on a young and strong camel, and who carries a provision of food and water. He mounts behind this companion, that his mare may be fresh and vigorous at the moment of attack. In approaching the enemy's camp, the horsemen advance, leaving their followers and the camels behind, with instructions to await their arrival. The horsemen are sometimes all destroyed in the expedition; and they are at other times separated from their followers who carry the provisions, and either inevitably perish in the barren plain, or submit to be stript and plundered by their enemies. In the most inveterate wars of the Arabs the women are invariably respected; and neither men, women, nor slaves, are taken prisoners. Night attacks are generally avoided, lest during the confusion the women's apartments should be entered, which would produce a desperate resistance, and probably in the end a general massacre—an extremity which the Arabs always try to avoid. The attack of a camp seldom occasions any great loss of lives, because no opposition is offered to superior numbers; and a Bedouin, except in avenging blood, never puts to death an unresisting foe. In flying from his enemy, an Arab may save his life by throwing himself from his horse and asking for mercy; but he saves it at the expense of his honour, and loses his horse and all his clothes, while his enemy will ever after triumph over him. The more spirited of the Arabs defy their adversary, while he pursues them, calling out repeatedly, "Howel, howel," get down, get down, and who, when his call is not obeyed, wounds or kills his enemy with a thrust of his lance. Among some of the Arab tribes it is the practice to steal unobserved on the enemy's encampment during the night, and knocking down the principal tent-poles, to drive off the cattle amid the confusion.

But the Arabs often undertake merely thieving expeditions, in which they steal from friend and foe. The mode in which these are conducted affords some curious details of manners. In such enterprises ten or twelve persons usually engage, and clothe themselves in rags, to make their ransom easier if they should be taken. When they approach the camp which they intend to rob, three of the most daring advance about midnight, when its inmates, who seldom plant sentinels, are buried in sleep. One of the thieves now endeavours to excite the attention of the watch-dogs. When they attack him he flies, and draws them off to a great distance, by which the camp is left unprotected. Another, called *el haramy*, or the robber, advancing towards the camels that are upon their knees before the tent, cuts the strings that confine their legs, when they rise and walk, as all unloaded camels do, without the least noise. One of the she camels being then led out of the camp, all the others follow. The third actor in the robbery watches at the tent door with a long and heavy bludgeon, with which he knocks down any of the inmates who may come forth. It often happens that as many as fifty camels are stolen in this manner, and driven away by forced marches during the night to a safe distance. In many cases, however, the robbers are surrounded and seized; and the mode of treating these prisoners is extremely curious, and is a proof how powerfully these fierce barbarians are influenced by prejudice and immemorial usage. It is an established custom among the Arabs, that if any person who is in actual danger from another can touch a third person, or any inanimate thing which the other has in his hands, or if he can touch him by spitting or throwing a stone at him, and at the same time exclaims "I am thy protected," he is bound to grant him the protection which he requires. This law, however absurd and capricious, seems naturally to arise out of scenes of violence, the evils of which it is calculated to soften. A prisoner detected in the act of plundering anxiously looks about for a protector, while the inmates of the tent are equally desirous to deprive him of this privilege. The person who first seizes him demands on what business he is come, accompanying his question by blows on the head. "I came to rob—God has overthrown me," is the common answer. The captor (the *rabat*), binding the hands and feet of his prisoner, and calling in the people of his tribe, addresses him, saying, "renounce;" and the robber, fearing a continuation of the blows, answers, "I renounce," namely, the benefit of any protector. But this renunciation being only valid for a day, the prisoner is secured in a hole dug

in the ground, about two feet deep, and large enough to contain him. Here he is laid, his feet chained to the earth, his hands tied, and his twisted hair fastened to two stakes on both sides of his head. Some tent-poles are then laid across this temporary grave, and corn-sacks and other heavy articles heaped upon them; a small opening being only left, through which he may breathe. Thus buried alive, the prisoner does not despair; and customs that are established among the Arabs sometimes favour his escape. If from his hole he can contrive to spit into the face of a man or a child, or if he receive a morsel of bread from a child, he claims the privilege of being protected. His mother or his sister sometimes contrive to enter the camp in which he is confined, in the disguise of a beggar. Approaching during the night the hole where he lies confined, and throwing a thread of worsted over his face, they guide it to his mouth, or fasten it to his foot; and by this token he knows that help is at hand. The woman winding off the thread, retires to some neighbouring tent, and awakening the owner, and placing the thread on his breast, addresses him in these words: "Look on me by the love thou bearest to God and thy own self—this is under thy protection." The Arab comprehends at once the object of this nocturnal visit, rises, winds up the thread, and being thus guided to the tent of the prisoner, awakens the captor, and showing the thread still held by the prisoner, claims him as his "protected." The right of freedom is at once allowed; the thongs which tied his hair are cut, his fetters are taken off, and he is entertained by the captor as his guest with all the honours of Arab hospitality. A prisoner sometimes remains for six months under this rigorous custody, always concealing his real name, and giving himself out for a poor beggar. He is generally discovered, however, when he must pay as a ransom all his property in horses, camels, sheep, tents, provisions, and baggage. In many cases a sum is agreed upon for his ransom, and he goes to his tribe to collect it, or find a surety for the payment. If he cannot collect the necessary sum among his friends, he is bound to go back to his prison; and he seldom fails either to pay or to return. A father considers his son to have acquired high honour in being detained as a robber, and he willingly redeems him with his whole property, which he hopes to recover in some future expedition.

Nobility of Arabia.

The Arabs are remarkable above all the nations of the earth for the spirit of clanship and for pride of family. The scheiks, or the rulers and nobles who govern Arabia, glory in their ancestry, which they can trace with undoubted accuracy to a long line of princes. Nobility of birth, which cannot be communicated by the smile of kings, is the true distinction of the Arabian aristocracy; and no scheik would exchange his title for any distinction depending on court favour. Those genuine nobles, who dwell in tents, look with contempt on the dwellers in cities, as a race debased by foreign alliances, which they hold in such contempt, that a scheik, if he were forced from poverty to marry his daughter to a citizen, would consider himself disgraced by the match. Besides the scheiks there are the sherifs or sejids, or, in the Mahometan countries to the north of Arabia, the emirs. These are the descendants of Mahomet, who hold the first rank among the great families of Arabia, and who receive the double honour that is due to splendid descent and superior sanctity. The title of sherifs distinguishes them from the scheiks, the common order of Arabian nobility. They are multiplied over all Mahometan countries. Whole villages are peopled with them, and they are frequently found in the lowest state of misery. The sherifs of the Hedjaz, who were once numerous, but are now reduced to a few families in Mecca, have never contaminated their pure blood by strange alliances; and they are esteemed above all the other descendants of the prophet. The presence of a sherif commands universal respect. In a fray no arm would violate his person; his property requires no protection; the sanctity of his character supplies the place of bolts and bars, and scares away the boldest thieves.

From these sherifs are chosen the rulers of Mecca and its adjacent territories, extending for about 250 miles along the coast, from Yembo on the north, to Haly or Gonfode on the south. Before the country was conquered by the Wahabys, and again by the Turkish troops under Mohammed Ali, they possessed the power of sovereigns within their dominions; and though they held their authority ostensibly under the grand signior, being installed in their office by an investiture of a pelisse from Constantinople, thus formally acknowledging themselves his servants, and praying for him in the great mosque, they were in reality elected by the powerful sherif families resident at Mecca, and they ruled according to the constitutional maxims of the desert, merely as Bedouin chiefs. The Arab tribes looked upon them as one of their own scheiks, the head of the family or clan; and they followed them in war under their own immediate chiefs, without receiving pay. In this manner Ghaleb, the last sherif, was accompanied in his wars against the Wahabys by 6000 or 8000 Bedouin Arabs. A system of well-regulated freedom was not to be expected from the rude policy of wandering shepherds, and the Arab chiefs accordingly own no restraint on their authority. But the rigour of despotic sway is softened by the influence of manners; and the independent princes of Mecca, in the pride of sovereignty, still acknowledge the ties which bind them to the simple Bedouins of the desert. The sherif descendants of Mahomet who reside at Mecca retain a singular practice of sending every male child, eight days after it is born, to the tents of some wandering tribe. Here he remains till his 8th or 10th year, when he is able to mount a steed, and sometimes till his 13th or 15th year. During all this period he only pays one short visit to his father's house, in his sixth month, when his foster-mother returns with him to her tribe. The boy is trained by those shepherds in all warlike exercises: he shares in their hardships and perils, is familiarized with their manners, and acquires their pure language, and a lasting influence over them; while his affections, awakened at an age when the mind is peculiarly susceptible, still attach him to the scenes of the desert and the companions of his youth. The tent of a Bedouin shepherd is in this manner the constitutional school of an Arabian prince, in which he imbibes the maxims by which he afterwards rules the state. Some of the sherif boys become so fond of their foster-parents that they can scarcely be reconciled to their fathers' house; and they have been sometimes known, after being settled at home, to escape to their friends in the desert. "The Bedouins," says Burckhardt, "in whose tent a sherif had been educated, were ever after treated by him with the same respect as his own parents or brethren: he called them respectively father, mother, brother. Whenever they came to Mecca they lodged at his house, and never left it without receiving presents. He considered himself during his life as belonging to the encampment in which he had passed his early years; he termed its inhabitants 'our people,' or 'our family,' took the kindest interest in their various fortunes; and, when at leisure, often paid them a visit during the spring months, and sometimes accompanied them in their wanderings and their wars." Sherif Ghaleb, whose reign was terminated by Mohammed Ali in 1815, was remarkably attentive to

his Bedouin friends. They alighted at his house in Mecca just as they alight at the tent of a scheik in any Arab encampment of the desert; and when they departed, their sacks were filled with provisions for the road. On their arrival he used to rise from his seat and embrace them, though they were in the same mean attire as the other inhabitants of the desert. Many of the sherifs are also married to Bedouin girls.

A sherif was generally succeeded by his relative, whether son, brother, or cousin, who had the strongest party, or the public voice in his favour; but it was seldom that an election took place without a violent contest, which frequently ended in bloodshed and civil broils. These, however, were carried on according to the laws of the desert, and they were seldom of long duration. The happiness of the people under these sherifs always depends on the personal character of the ruler. There are no tribunals to which the oppressed can fly for redress, and a sherif may harass his subjects to any extent by his extortions. He may imprison the refractory, and even put them to death, without endangering his authority. Such is the despotic character of all eastern governments.

In the Ottoman provinces the dignity of sherif is less respected, though even in Turkey they enjoy some substantial privileges. In the towns where they reside, the sherif or emir is subject, not to the pacha, but to a member of his own family, who is denominated nakib or general of the sherifs. Besides the scheiks and sherifs there is another branch of nobility at Mecca, who have an hereditary right to certain employments at the mosque, and who have a strong inducement to preserve an exact record of their genealogy. These are certain families descended from the tribe of Koreish, who hold the office of keeper of the keys of Kaaba, which is the most important office about the mosque, and was often an object of contention among the ancient Arabian tribes; and others who are muftis, or are employed in other capacities, and who, to preserve their title to these envied privileges, can show a faithful record of their ancestors for ten centuries back. There were formerly 12 other illustrious families of the tribe of Koreish, who are now reduced to three.[1]

Government.

Arabia is divided into numerous petty states, governed by independent chiefs or scheiks, who are, strictly speaking, the heads of families; and the paternal government thus supplies the model of the Arabian institutions. The father is in all cases the natural ruler of his own family; and though the tie be necessarily weakened as families multiply, yet the relations of kindred and of blood are still acknowledged, and all the descendants unite in paying respect and reverence to their common head. An assemblage of families constitutes a tribe; and all the scheiks of the same tribe acknowledge a common chief, who is called the *schech es scheuch*, or the scheik of scheiks, or the grand scheik or prince, who rules over the whole. The dignity of the grand scheik is hereditary in the family; but it is so far elective that he is chosen by the inferior scheiks, from the whole members of the reigning family, without regard to seniority or lineal succession: his only distinction is his qualification for the office. The right of election, as well as other privileges which belong to the inferior scheiks, obliges the grand scheik to treat them rather as associates than as subjects, and in some measure to share with them his sovereign authority. If they are aggrieved by him, they depose him, or emigrate with their cattle to other tribes; and in this manner many powerful tribes have been weakened, while the number and the power of others have been augmented.

The scheik has in fact no acknowledged or formal authority over his tribe. His commands would be treated with contempt, and his advice only is received with the deference due to experience and talent. "The prerogative of the scheik," says Burckhardt, "consists in leading his tribe against an enemy, in conducting negotiations for peace or war, in fixing the spot for encampments, in entertaining strangers of note; and even these privileges are much limited. The scheik cannot declare war or conclude peace without consulting the chief men of his tribe. If he wish to break up the camp, he must previously ask the opinions of his people concerning the security of the roads, and the sufficiency of pasture and water in the districts to which he directs his view. Thus he strikes his tent and loads his camels without desiring any one to do so; but when they know that the scheik is setting out, his Arabs hasten to join him." The Arabs are jealous of authority, and their freedom borders on anarchy. The Bedouin acknowledges no master but the Lord of the universe; and the most powerful chief, by inflicting punishment on the poorest man of his tribe, is exposed to the mortal vengeance of himself or his relations. A scheik, in place of deriving a yearly income from his tribe, is bound to show liberality, especially in his treatment of strangers; to maintain the poor, and to divide among his friends whatever presents he may receive. The only revenue possessed by the northern chiefs is the tribute which they extort from the Syrian villages, and from the pilgrim caravan to Mecca. Among the numerous principalities in the south of Arabia, the scheik or imam imposes a land tax and a poll tax, also port and transit duties on all articles of merchandise, some of which, as on coffee, are very heavy. These duties on goods are not, as they have been sometimes considered, a mere ransom from pillage, but a tax and an acknowledgement of the paramount authority of the prince. Among so many petty sovereignties wars frequently arise, from the ambition or jarring interests of the different chiefs. The more powerful princes frequently oppress their weaker neighbours; and in the fertile districts of the country extensive monarchies have arisen from conquest or religious prejudices, on the ruin of the smaller states. Of these are the dominions of the sherif of Mecca, and of the imams of Sana and Mascat; many sherifs are under the control of the Bedouins. In some cases these smaller states have associated for their common defence; and, from the disunion or hostility of its various tribes, the country has been in all ages a scene of rapine and intestine wars. In later times the rise of the Wahaby power crushed all the inferior chiefs, and on their ruins had arisen a powerful empire, which was overthrown by the Egyptian army of Mohammed Ali.

Administration of justice.

The Arabs, though they enjoy a rude independence, have made little progress in the arts and institutions of civil life. In administering justice, they resort to the most barbarous expedients. The scheik has not the power of enforcing obedience to any sentence if it is not agreed to by the parties. The kady, so often mentioned by the Arabian writers, is the only judge; and such of them as still remain are famed for being expert in the laws and customs of the nation, and for their integrity. The office of kady continues in one family, but is not confined to any individual, a choice being made of the fittest person in the family by the other kadys of friendly tribes, as well as by the people of his own tribe. The kady is paid by the litigating parties; but all the judges, especially those in towns, are open to bribery, and justice is sold to the highest bidder. In cases where the witnesses directly

[1] Burckhardt's *Travels in Arabia*, vol. ii. p. 127.

contradict each other, some superstitious ordeal is used to discover the truth. A particular judge is appointed for cases which must be decided by supernatural means. He directs that a fire shall be kindled before him: "he then," says Burckhardt, "takes a long iron spoon, used by the Arabs in roasting coffee, and having made it red-hot in the fire, he takes it out, and licks with his tongue the upper end of the spoon on both sides. He then replaces it in the fire, and commands the accused person first to wash his mouth with water, and next to lick it as he had done. If the accused escape without injury to his tongue he is supposed innocent; if he suffer from the hot iron he loses his cause. The Arabs ascribed this wonderful escape, not to the Almighty protector of innocence, but to the devil." In all cases of manslaughter or murder where the fact is denied, this superstitious ordeal is appealed to, and no other mode of trial admitted. Where the parties refuse the decision of the judge, they resume their original right of avenging their own quarrel; and a strife of this nature once begun, and producing blood-shed, leads to a long series of cruel retaliations.

Among the Arabs crimes of every description are punished by fines; corporal punishments are entirely unknown; and there are no prisons to circumscribe the freedom of the desert. For every offence a fine is fixed in the kady's court, which is rigidly exacted: all insulting expressions or acts of violence, from a slight blow to wounding and the effusion of blood, have their respective penalties. They adopt the following singular mode of ascertaining the fine payable for killing a watch-dog: The dead dog is held up by the tail, so that its mouth just touches the ground; its length is then measured by means of a stick, which is fixed in the earth, and the offender is obliged to pour out over the stick as much wheat as will wholly cover it, which is then given to the owner of the dog. The form observed by an Arab in summoning witnesses is by exclaiming, "Bear thou witness, O ——;" or he may touch their arms with his hand, which is considered as a summons to give testimony. Where a party is accused of a crime, and there are no witnesses, the matter is referred to his oath. The judicial oaths of the Arabs have different degrees of sanctity; and for certain oaths they have a superstitious veneration, which induces them to tell the truth. One of the most common oaths is for a party to take hold with one hand of the middle tent-pole, and to swear "by the life of this tent and its owners." The following oath is often taken before the kady: A small piece of wood or some straw is presented to him who has to swear, with these words, "Take the wood, and swear by God, and the life of him who caused it to be green, and dried it up." Another oath, even more solemn, is the "oath of the cross lines," where the accuser leads the person accused of theft or any other crime to a distance from the camp, on account of the magical nature of the oath; and with his crooked knife drawing on the sand a large circle, with many cross lines inside of it, and obliging the defendant to place his right foot within the circle, he himself doing the same, he addresses him in the following words, which the accused is obliged to repeat: "By God, and in God, and through God, I swear I did not take it, and it is not in my possession."

A singular institution, that of the wady or guardian, prevails among the Arab tribes. An Arab may in the prime of life request a friend to act as guardian to his children. If he accepts the trust, his friend presents himself before him with a she-camel; and leading it over to him, says, "I constitute you guardian for my children, and your children for my children, and your grandchildren for my grandchildren." In this manner one family is constituted the hereditary protectors of another family; and thus this fierce and warlike community, the prey of continual dissension, is held together by its own peculiar ties, domestic as well as political. To the weak, such as minors, women, and old men, the system of guardianship affords some security, however imperfect, against the oppression of the strong.

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Law of revenge for blood.

The Arabs are naturally a jealous and haughty people. They betray the quickest sensibility to an affront or injury, and carry the principle of revenge to the greatest excess. They consider the redress of their own wrongs as equally a duty and a privilege; and there are certain affronts and trifling violations of punctilio, which can only be expiated by the blood of the offender. To spit beside another is considered an insult which must be avenged; and Niebuhr mentions the case of an Arab who was so highly incensed at one of his neighbours for accidentally spitting on his beard, that he was with great difficulty appeased, although the offender humbly asked pardon, and kissed his beard in token of submission. If one scheik says to another with a serious air, "Thy bonnet is dirty," or "The wrong side of thy turban is out," it is considered a mortal offence. Murder is the deepest injury that can be committed; and the Arab code regulates the revenge for blood by the nicest rules. It is a universal maxim, that he who sheds blood owes on that account blood to the family of the slain person; and this debt may be required not only from the actual murderer, but from all his relations. These claims constitute the right of *thár*, or of "blood revenge." In the case of a slain parent, the fifth generation of his lineal descendants inherit the sacred duty of avenging his blood on a corresponding series of descendants on the other side; and this right is never lost by prescription, but descends to the latest posterity. If the death of the person killed is retaliated on one only of the murderer's family, the account is considered to be cleared, though mutual hatred soon renews the quarrel. If two of the murderer's family be killed by the relations of the deceased, the former retaliates; "the interest and principal of the bloody debt," says the great Roman historian, "are accumulated; the individuals of either family lead a life of malice and suspicion; and fifty years may sometimes elapse before the account of vengeance be finally settled." But a murder may be compounded for money. The nearest relations of the persons slain may accept the price of blood, which varies among the different tribes from 1000 piasters, or L.50, to 500 piasters. Among the Aenezes the blood of one of the tribe is compensated by 50 she-camels, one riding camel, a mare, a black stone, a coat of mail, and a gun; though it is seldom that all these articles are required: that of a stranger by the price paid in the stranger's tribe. The matter being finally settled, a she-camel is brought by the homicide to the tent of his adversary, and there killed, the blood being supposed to expiate that of the person slain. The hostile parties feast upon this camel; and at parting, the homicide flourishes a white handkerchief on his lance, as an emblem of his purity from guilt. Some of the great scheiks, however, account it shameful, and contrary to the true spirit of the Arab law, to compound the price of blood; and they invariably refuse to commute into a fine the sacred duty of revenge. Niebuhr mentions that he was visited by an Arabian of distinction at Loheia, who was bound to avenge the murder of a relation, and who told him that he was often haunted in his sleep by the fear of meeting his enemy. In the course of the continual wars in which the Arabs are involved, debts of blood are frequently incurred. The blood of those who are killed in the heat of battle is required at the hands of their

Arabia. enemies; and when any tribe violates the laws of war by slaughtering their enemies as they lie wounded on the field, the hostile tribe retaliate by killing double the number of their enemies with the same circumstances of cruelty; and hence long and bloody animosities frequently arise.

Tents. The tent of the Arab is covered with pieces of stuff made of goats' hair stitched together, which afford a complete shelter against the heaviest rain. The tent is divided into two parts, one for the men, and the other for the women, whose respective apartments are separated by a white woollen carpet of Damascus manufacture, drawn across the tent, and fastened to the three middle parts. The men's apartment is covered with a good Persian or Bagdad carpet; the women's apartment is the receptacle for all the rubbish of the tent, the cooking utensils, the butter, and water-skins, &c. The height of the tent is seven feet, its length from 25 to 30 feet, and its breadth about 10 feet. The articles of the tent consist of saddles and camel furnishings; large bags for holding water, made of tanned camel-skin; goat-skins for holding camel's milk, wheat-sacks made of wool or goat-hair; the leather bucket for bringing up water from deep wells; a large copper, the mortar, the hand-mill, wooden dishes, the coffee-pot, the iron chain which fastens the horse's fore-feet while he pastures about the camp. They have no chairs throughout the East, the universal practice being to sit cross-legged. In the Arabian towns the houses are built of stone, and have always terrace roofs. The houses of the tribes on the banks of the Euphrates are formed of the branches of the date-tree, and have a round roof covered with rush mats.

The dress of the Arabs is a coarse cotton shirt, over which the wealthy throw a long gown of silk or cotton stuff. Most of them, however, only wear over their shirt a thin, light, and white woollen mantle, or one of a coarser or heavier kind, striped white and brown. The mantles worn by the scheiks are interwoven with gold, and sometimes may be worth L.10 sterling. Some of the most considerable tribes, as the Aenezes, do not wear drawers, which are reckoned shameful for a man; and they usually walk and ride barefooted, even the richest of them, although they greatly esteem yellow boots and red shoes. They wear on their head a square kerchief of cotton: a few rich scheiks wear shawls of Damascus or of Bagdad manufacture. In winter they wear over the shirt a pelisse made of several sheep-skins stitched together. Many wear these skins even in summer, as they are taught by experience that thick clothing is a defence against the sun's rays. The Arab endures with wonderful constancy the extremes both of heat and cold. In winter he sleeps barefooted in an open tent, where the fire is not kept up beyond midnight; and in summer on the burning sand, under the intense rays of the sun. The dress of the women consists of a wide cotton gown of a dark colour—blue, brown, or black—and on their heads a kerchief. Silver rings are much worn by the Aeneze women, both in their ears and noses. They wear glass or silver bracelets, of various colours, round their wrists and their ancles, and silver chains about the neck. They go barefooted at all seasons. The women wear over their faces a dark-coloured veil, which conceals the mouth and chin. Near Mecca and Tayf, and beyond these places southward, both men and women dress most commonly in leather. They both wear a leather apron round their loins, the women a larger one than the men, reaching down to their ancles, and adorned with many tassels. In summer the men wear no other clothing.

Diet. The diet of the Arabs consists everywhere of flour and butter, variously made ready. Unleavened paste of flour and water, baked in ashes of camel's dung, and mixed up afterwards with a little butter, and thoroughly kneaded, is served up in a bowl of wood and leather. Flour and sour camel's milk, made into a paste and boiled (*thé ayesh*), is the daily and universal dish of the Aenezes. Bread baked in cakes is used at breakfast. Bread, butter, and dates, are also mixed together into a paste. *Burgout*, the common dish of the Syrian Arabs, is wheat boiled with some leaves, and then dried in the sun; it is preserved for a year, and served up with butter and oil. The Arabs never indulge in luxuries, except on a festival, or the arrival of some stranger; and the richest scheik would think it a shame to order his wife to dress any rare dish merely to please his palate. For a guest of distinction a kid or lamb is prepared, and for one of less consideration coffee or bread with melted butter. In Hedjaz, or the hilly district of Arabia near the Red Sea, the usual dish is Indian rice, mixed with lentils, and without any bread; and in the districts where the date grows it forms the chief sustenance of the inhabitants. In Nedjed, Hedjaz, and Yemen, the Arabs use butter to excess. They frequently swallow a whole cupful of butter before breakfast, and all their food swims in butter. The constant exercise and motion to which they are accustomed so strengthens their powers of digestion, that they can endure without injury the extremes of excess and want. They can live for months on the smallest allowance, or devour at a sitting the flesh of half a lamb. Butter is made from the milk of sheep and goats; but never, except in cases of necessity, from that of camels. Among many of the Arab tribes it is considered shameful to sell any butter, or among the Bedouins near Mecca to sell milk; yet the Beni Koreish, one of the most noble of the Arabian tribes, freely supply the inhabitants of Mecca with milk.

Hospitality. Hospitality, the virtue of rude nations, is practised among all the Arab tribes, and no violation of its duties was ever known. When a stranger alights at the tent, the host, or in his absence the wife or daughter, spreads a carpet for him and prepares the hospitable meal. If he remains any time his aid is expected in the domestic business of the tent, in fetching water, milking the camel, or feeding the horse. But he may neglect these duties and still remain, though he will be censured for ingratitude; or he may go to another tent, where he will receive a hearty welcome; and every third or fourth day may change his residence, and be comfortably entertained during his stay, however long it may be. The greatest insult that can be offered to an Arab, is to tell him that he does not treat his guests well. Among some tribes women never eat or drink coffee in the presence of a man; and in this case some male relation, in the absence of the host, does the duties of hospitality. In the plain of Hauran, southward of Damascus, the wives and daughters of the Arabs may drink coffee with the strangers upon their arrival; and in the mountainous districts south of Mecca, towards Yemen, women are allowed, in the absence of their husbands, to entertain a guest, and to sit up with him.

Law of marriage. The Arabs are not so dissolute in their morals as most of the nations in the East. They are generally content with one wife: instances of conjugal infidelity are not common, and public prostitution is not seen in their camps. Yet they are far from being duly impressed with the sacred tie of marriage, which may be at any time dissolved at the pleasure of the husband; and this facility of divorce relaxes morality, though, to some extent, the manners correct the laws. A Bedouin, aware that a divorce is always in his power, contracts a temporary marriage of a few weeks; and it is not uncommon for a

man, before he has attained the age of 40 or 45, to have had 50 wives. The wife also, if she is ill used, may fly for refuge to her father's tent, whence she cannot be reclaimed by her husband. Yet among the Bedouins many instances are found of conjugal fidelity and love. This rash dissolution of the marriage union is frequently fatal to the peace of one or of both parties. In 1815, Burckhardt mentions that a Bedouin of the Syrian desert, who had divorced his wife, and who was present at her second marriage, shot himself in a fit of distraction, the moment he saw the new husband enter the marriage chamber. The Wahaby ruler Saoud exerted all his authority to prevent the frequent divorces of the Arabs, by disgracing at court, or otherwise punishing, any man who either divorced his wife or used the expression *Aley et talak*, "I shall divorce," which, according to the Arab law or custom, cannot be revoked. Polygamy is permitted, but is not common, among the Arabs, owing chiefly to their poverty. The richer scheiks, however, indulge in a plurality of wives. The marriage ceremony among the Aenezes and most of the Arab tribes is extremely simple. The lover generally commences, through a common friend, a negotiation with the father of the girl; and if she is pleased, the friend, holding the father's hand, says, "You declare that you give your daughter as wife to ———;" to which the father assenting, the bridegroom comes on the marriage day with a lamb in his arms to the tent of his betrothed, and by cutting its throat before witnesses he completes the marriage ceremony. After the usual rejoicings the bridegroom retires after sunset to a tent at a distance from the camp, while the bride, in her maiden timidity, runs from tent to tent, struggling, kicking, and even biting those who attempt to conduct her to the bridegroom's chamber.

Rite of circumcision.

The rite of circumcision is still practised among the Arabs, and is the occasion of a great festival. All the boys are generally circumcised on the same day. Each man of the encampment kills at least one sheep in honour of his son, and the whole tribe feast on this abundant cheer. The men exhibit equestrian exercises and warlike evolutions; while the young women join in the national airs, and sometimes removing their veils, allow their lovers a hasty glance of their beauty as they pass. There are, besides, the festivals of Ramadhan and of the sacrifice of Arafat, where the same exercises are exhibited.

Mechanical arts, literature, music.

The Arabs are no great proficients in arts or industry, their only artists being a few blacksmiths to shoe the horses, and saddlers for the leather work. The arts of tanning and weaving are practised, the first by the men, the latter by the women. Of reading and writing all the Bedouins throughout Arabia are equally ignorant. The Wahaby chiefs were at pains to instruct them, and sent teachers among the different tribes, but with little effect. Nor have they made any progress in science or literature. In the first, their knowledge is confined to the names of the constellations and planets. Their literature consists in romantic tales of love and war, in which they delight; and the minstrel's strain frequently beguiles the evenings of an Arab encampment. Verses are recited or sung, and the voice is accompanied by a species of guitar, the only musical instrument which they possess. They have national airs also for female singers, which are chanted in choruses of six, eight, or ten voices, at some distance from the camp, in the solitude and silence of the desert. Many of the Arabian poets can neither read nor write, yet compose verses of exact measure, grammatically correct, and neither destitute of sentiment nor poetical beauty. Eloquence has from time immemorial been considered a necessary qualification of an Arab statesman: no scheik, however brave, can ever attain to influence among the Arabs without this talent. The language of Arabia is derived from the same original stock with the Hebrew, the Syriac, and the Chaldean tongues. Each tribe has its own peculiar dialect, but, by universal consent, the palm of elegance and purity has been, and still continues to be, assigned to the idiom of Mecca.

Moral character of the Bedouins.

The preceding details exhibit in no very favourable view the moral character of the Arabs; and the boasted virtues of the desert, when they are calmly estimated, seem to resolve into the observance of certain rules or prejudices, without which no community can exist, however rude or lawless. The thieves and outcasts of civilized society are linked together by certain ties of good faith, without which all concert would be impossible even for their own evil ends; and the honour that prevails among the Arabs seems not to be of a much higher quality. They are, according to the accounts of all travellers, immoderately fond of gain, which they do not scruple to procure by the basest means. "Lying, cheating, intriguing, and other vices arising from this source, are as prevalent in the desert as in any of the market-towns of Syria; and on the common occasions of buying and selling, where his dakheil (oath) is not required, the word of an Arab is not entitled to more credit than the oath of a broker in the bazaar of Aleppo." An Arab will defend his guest at the peril of his own life; he will submit with resignation to the most cruel reverses of fortune; and at Mecca, during the pilgrimage, the true Bedouin of the desert, unlike the other pilgrims, disdains to ask alms, and always lives by his own industry, however precarious or humble. On the other hand, in pursuing the trade of rapine, he seems to be degraded, by his thievish, cruel, and treacherous habits, to the lowest rank of barbarism. In their familiar conversation the Arabs are free, sprightly, jocose, and decent. They are not reserved or silent, according to the report of some travellers, except perhaps in their journeys through the desert, where much speaking excites thirst, and parches the mouth. In their tents they are indolent, all that they do being to feed the horse, or milk the camels in the evening. The herds and flocks are committed to the care of a shepherd hired for the purpose; and the husband goes out to hunt with his hawk, or to amuse himself in any other manner that pleases him; while the wife and daughters are engaged in the household cares, in grinding the wheat with the hand-mill or pounding it in the mortar, in kneading and baking the bread, making butter, fetching water, working at the loom, or mending the tent-covering. They are patterns of industry, yet they are not allowed to eat with the men, and only partake in their own apartments (the *meharrem*) of what they leave. If a lamb is killed, they seldom taste, except some of the worst parts, which the men are not able to eat. This degradation of the women is common to the Arabs with other Asiatic nations, and is a true feature of oriental barbarism.

Diseases.

The small-pox continues to make serious ravages among the Bedouins, and to depopulate whole encampments. Inoculation is resorted to with benefit, and the practice of vaccination has extended over Syria. Obstructions and indurations of the stomach, occasioned by the use of camel's milk, are common; but these complaints are alleviated by the purging qualities of the brackish water of the desert: also fevers, both intermittent and inflammatory; and the burning with a hot iron is here, as in the former case, the approved cure. Ophthalmic disorders are frequent, and leprosy, which is hereditary in families, and cannot be eradicated. It commences with white spots, as large as the hand, which appear on various parts of the

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body, without rising above the skin. If the white spots appear on the cheek, the beard commonly falls off: the unfortunate sufferer is held in universal abhorrence. The toothache is unknown among the Arabs, who have all the most beautiful teeth.

Towns.

The chief towns of Arabia are situated either on the coast of the Red Sea, or in the range of mountains which runs parallel to its shores. They are, Medina, with Yembo its sea-port; farther south, between 200 and 300 miles, Mecca, with Djidda its sea-port; Tayf, east of Mecca; still farther south among the mountains, Sada, Sanaa, and on the coast of the Red Sea, Gonfode, Loheia, Hodeida, and Mocha; Derayeh is in the interior, and Mascat on the coast of the Persian Gulf. The population of the towns consists chiefly of foreign traders, who follow the customs of the place, but seldom imbibe the national spirit. Hence they form an entirely different class from the Bedouin Arabs. They have their faults without their virtues, are dissolute in their manners, and addicted to the grossest vices. The commerce and religion of Arabia concur to bring together in the towns a mixed population from the most remote parts of the world.

Commerce.

Arabia has few manufactures, for a supply of which it is therefore dependent on its foreign trade. From its central position, however, and its contiguity to the shores of the Red Sea, in former times the only navigable communication between Asia and Europe, it has always been a great entrepôt for the commodities of other countries. In the ancient world it was the medium of intercourse between India and Europe, and still continues to enjoy a portion of this commerce.

The sea-port of Djidda, on the Red Sea, seems to be the great emporium of the Arabian trade. Thither resort the annual fleets from Calcutta, Surat, and Bombay, about the beginning of May. They bring piece goods, Cashmere shawls, cocoa-nuts, rice, sugar, drugs of all sorts; small articles of Indian manufacture, such as china-ware, costly collections of which are often displayed by the rich inhabitants; hardware, pipes, beads, wooden spoons, glass beads, knives, rosaries, mirrors, cards, &c. See DJIDDA.

In Arabia, as in most other eastern countries where property is not protected, capital is slowly accumulated, and is in general far from abundant. The rate of profit is consequently high, amounting to 30, 40, or even to 50 per cent. No money can be lent out at interest as in Europe, it being contrary to the law of the Koran, and no one besides having confidence in another. There is no monied interest in Arabia. There are no stocks of any description, or public funds, in which money can be invested; and every capitalist is therefore engaged in trade, from which he never can withdraw to live on his money as in Europe. Credit is with difficulty obtained, and trade is carried on by means of barter or by sales for cash. Hence no Arabian merchant can contract debts which he is unable to pay; and there are consequently no mercantile failures in Arabia as in Europe.

The utmost profligacy of manners prevails in all the Arabian towns, as indeed in all Mahometan countries; and the holy temple, the very sanctuary of the Mahometan religion, is daily profaned by the grossest depravities, to which no shame is attached. The young of all classes are encouraged in those immoralities by the old; and even parents connive at the disgrace of their children, and profit by their iniquities. From such vices the encampments of the Bedouin Arabs are alone said to be exempt.

Later discoveries.

Between 1824 and 1827, and again in 1833 and 1834, Mahommed Ali, the late Pasha of Egypt, sent his armies across the great chains of Hedjaz and Yemen with a view to subjugation the fierce highlanders of Assyr. Among his staff-officers were several French gentlemen of scientific attainments, among whom Mr Chedufeau, who was chief of the medical department, occupied the principal place. To the zeal of this gentleman we owe much valuable information concerning the geography and the inhabitants of a large tract which was, until then, only known by hearsay. This tract occupies the eastern slopes of the centre of the Hedjaz-Yemen chain, and extends from Tayef, or about north latitude 21° in the north, to the 18th northern parallel in the south, and east as far as about east longitude 45°, no astronomical computations having been made. The country is very mountainous, the slope being eastward, and watered by many streams which form several large and well populated wadis. The principal are Wadi Subey and Wadi Zahran, east and south of Tayef, and farther south, Wadi Shamram and Wadi Zebran, which is the upper portion of Wadi Bisheh, the most extensive and best cultivated of them all. El Assyr proper occupies the south-west. Far in the east is Wadi Dowasir, and in the south, the fine valley Wadi Nedjran, the inhabitants of which are said to be the handsomest men in Arabia, and in the past century raised their country to much political importance among the petty Arab states. This tribe possesses large herds, and many excellent horses, which are highly esteemed at Sana. The united streams of the northern portion of this extensive tract form the River Tarabah, and those of the south the River Bisheh, both carrying a considerable volume of water, and flowing east, much beyond the limits of the Egyptian expedition in that direction. Between these two river systems there is the Wadi Raniah, which is watered by a goodly stream flowing into Lake Waradah. Great water-courses having been denied to Arabia, notwithstanding Ptolemy's statement of five (large and permanent) rivers, the question naturally arose, "where do these rivers of Assyr, which receive the whole volume of water which descends from the eastern slopes of a chain extending at least over three degrees of latitude, ultimately flow to?" According to the Arabs questioned by the French officers, they discharge themselves into a large lake, Salomeh, which appears to lie in the latitude of Mecca, and about east longitude 45°. The announcement of a large inland lake in the arid interior of Arabia, was at first startling, but it is supported by the statements of Arabic geographers, whose *Feledj-el-Afladj* in Yemamah seems to occupy the environs of this hitherto unvisited lake. They speak in high terms of the numerous water-courses of Yemamah, many districts of which are called *Feledj*, literally a canal of irrigation, of which *afladj* is the plural. But here a similar question rises as above,—"where does the surplus water of Lake Salomeh flow to?" Undoubtedly eastward, whence it is but natural to assume that the great river El Aftan, the lower course of which has been traced underground in Bahrein, is but a continuation of the river flowing into Lake Salomeh, which in its turn presents all the features of the upper course of a large river, as it is the confluent of a great number of mountain streams carrying a considerable and permanent volume of water, and meandering through a large extent of country.

Mareb.

The high table-land on which lies the city of Sana, and which is overtopped by many lofty peaks, slopes rapidly down in the east towards the plains of El Djof-el-Yemen. Many *seils* or torrents precipitate themselves from its acclivities, forming narrow and steep passes through which the traveller descends into the burning lowland. An old tradition, supported by the evidence of Greek and Arabic geographers, and confirmed by the statements of intelligent natives, identifies Mareb, the capital of that district, with the ancient Saba or Sheba, whose queen once visited Solomon. All Arab writers agree that Mareb, although an inconsiderable place at the various periods in which they wrote, was still surrounded by vast ruins, the remnants of its former grandeur. It was said, that with a view to procuring a constant supply of water for the irrigation of their wadi, the inhabitants, in time immemorial, had constructed an immense stone wall across their valley, but above the town. The water flowing down from the high mountains in the west, was thus collected beyond the dike, where it expanded into a large and deep lake. The dike, however, gave way, and an irresistible flood not only destroyed the town below it, but also the cultivated fields in the valley; and the inhabitants being unable to raise the wall up again, the whole extensive district was changed into a desert. When Niebuhr was at Sana, he gathered much valuable information concerning those water-works, and the destruction of that vene-

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rable metropolis of the Himyaritic kingdom, but neither he nor any other European succeeded in penetrating to that classic spot, till in 1843 an enterprising young Frenchman, Thomas Joseph Arnaud, accomplished the task at the imminent risk of his life. His description tallies with and confirms the accounts of Niebuhr and others. Mareb, the splendid *Mariaba metropolis* of Ptolemy. is now a miserable village surrounded by a brick wall, but the environs are covered with ruins, testifying its past greatness, and marking the area it once covered. The ancient residence of the queen of Sheba, or perhaps that central portion of it which formed the city properly speaking, was of a circular shape, about a mile in diameter, and encompassed by a massive wall of free-stone. Within and without its ruined precincts, lie scattered about innumerable fragments of solid buildings, large square stones, portions of brick masonry, friezes, and other house ornaments, and even whole columns hewn out of a single block of the hardest limestone. West of the ancient town are the ruins. They are the extensive remains of the outer wall of a palace which the inhabitants call Haram Bilkis, "the palace of Bilkis," in memory of the Sabæan or Himyaritic queen Bilkis, who is not only said to have been the founder of that royal residence, but is also identified with the queen of Sheba of Scriptural renown. A portion, about one fourth, of the wall is still standing, and covered with Himyaritic inscriptions, of which Arnaud copied as many as circumstances would allow him. Other inscriptions are found on many of the large blocks which lie scattered about.

The great dike.

The ruins of the famous dike are to the east of the town. There the bed of the Seil Dana, a torrent, dry in the summer, but swelling into a deep and impetuous river in the rainy season, is hemmed in by two mountains, forming a gate through which the flood rushes into the plain. Each of these mountains is called Balak. They are 600 paces asunder, and between them the ruins of the stone dike occupy an area 300 paces long, between the bases of the two Balaks, and 175 paces wide in the direction of the current. The portions leaning against the projecting foot of the mountains are still in such a state of preservation as to allow the examiner to guess their destination. There are many gates or openings in the wall through which the water was allowed to escape into the plain below; they are in perfect preservation, and constructed at different levels, so as to secure a regular supply. As far as the traveller's eye could reach from the adjoining hill, the bed of the Dana and the plain on either side was strewn over with fragments of masonry, giving the whole the appearance of a vast cemetery covered with tombstones. Previous to the breaking of the dike, the wadi was fertile and cultivated for a distance of seven journeys, but it is now a sandy desert through which, in the rainy season, the torrent of the Dana rushes on towards the interior. It seems to be the upper course of the river which waters the Wadi Maifah, which opens towards the sea below Nakab-el-Hadjar, and west of Hisan Ghorab, both renowned for the Himyaritic inscriptions which have been discovered there.

El Yafa.

The tract bordered in the north by El Djof, and in the west by the southernmost portion of the highlands of Yemen, and the Tehama of Aden, near Ras Seilan, in the east by the Wadi Maifah, and in the south by the Indian Ocean, is called El Yafa. It is subdivided into several smaller districts. Along the sea stretches a tehama. Above it rises a section of the great southern mountain chain with peaks attaining an elevation of above 5000 feet, such as Djebel Amzuk and Djebel Hammari. North of this chain the country is a high table-land untrodden by Europeans. The central portion of El Yafa is bisected by a considerable river coming from Damar, in Yemen, and which, after having washed the principal town, Yafa, breaks through the high range and loses itself in the sand of the tehama. But the river Meidam, on the frontiers of Yemen, is a permanent stream—a rare thing in Arabia—and in all seasons of the year reaches the sea in the Bay of Tuwayi, near Aden. The high plateau of Yafa is barren, but the valleys and slopes of the mountainous portion are fertile, well cultivated, and well inhabited. Coffee is cultivated in Yafa, but only in its western parts.

Hadhramaut.

Hadhramaut was a *terra incognita* until a very recent date. The Europeans had heard of a Wadi Doan, praised by the Arabs for its fertility, its numerous well-built towns, and its flourishing commerce. But its position remained uncertain. Niebuhr, following the vague statements of some natives of Hadhramaut, who probably intended to deceive him with a view to deter him from proceeding thither, placed it in the far north-east of that province, at many hundred miles from the place where it was subsequently discovered; and all later geographers blindly copied the mistake, although Seetzen, who had drawn his information from more credible sources, determined its position with approximative accuracy as early as the beginning of this century. The lovers of Arabic geography and antiquities, nevertheless, kept their eyes on that celebrated wadi, as it was expected that monuments and other traces of the ancient Himyaritic power would be found there. At last the late Lieutenant Wellsted discovered Himyaritic inscriptions at Hisan Ghorab, near Ras Kell or Dog Cape, and others at Nakab-el-Hadjar, in the Wadi Maifah, which he had ventured to visit. His account excited unusual interest in England and on the Continent, and several distinguished scholars devoted their energies towards the deciphering of these time-honoured mysterious characters. Moved by such and similar considerations, a man now entered the arena of discovery who already takes rank among the most eminent explorers of Arabia, although his sojourn in the unknown land was shortened by the jealousy of fanatic Bedouins, and the account of his researches has not yet been placed before the public.

The Baron von Wrede.

In the year 1843, the same in which the Frenchman Arnaud discovered the ruins of Saba, the Baron von Wrede, a German gentleman, who, during a long sojourn in Syria, Egypt, and Arabia, had made himself thoroughly acquainted with the Arabic language and oriental manners, started from Cairo with a firm determination to explore the Wadi Doan and other parts of Hadhramaut. He succeeded, though only partially, but still at the risk of his life. Travelling in the disguise of an Egyptian, on a pilgrimage to the tomb of the prophet Hud, he passed as such, in the eyes of the natives, for a considerable time. Suspicion, however, arose, and he was ultimately discovered to be a European and a Christian. He was thrown into prison, and kept there during three days, hourly expecting death; but the Sultan of Grein having succeeded in quieting the fanatical Bedouins, who cried for his blood, granted him life and liberty on condition of his leaving the country without delay. He did so under the safeguard of the sultan, but deprived of his wardrobe, his money, his instruments, and many, but fortunately not all, of his papers and drawings. After his return to Cairo, he wrote an account of his researches and adventures, from which the following outlines of Hadhramaut are extracted.

Name.

"Hadhramaut" is said to mean "the country of death," either in allusion to its pathless deserts, or to the curse of the prophet Hud, who, according to an old Arabic legend recorded in the Koran (chap. vii., El Ahraf, and chap. xlvi., El Akhaf), punished the unbelieving and blasphemous tribe of Ad, who dwelt in that part of Arabia, by sending a fiery wind into the country, which reduced the fertile fields to burning deserts, and destroyed its inhabitants. But this etymology is questionable. In its larger meaning, Hadhramaut comprehends the immense tract between Yafa and Oman, which is separated from the heart of the peninsula by the desert El Ahkaf. The traveller only visited the south-western portion of it, namely, the Wadi Doan, its environs, and the tract between it and the sea.

Mountains.

This province of Arabia, like all others bordering on the sea, consists of three distinct physical portions, viz., *firstly*, a narrow tehama intersected in some places, as at Ras Farlak, by spurs of the inland mountains advancing upon the ocean, and forming lofty projecting capes; *secondly*, a serrated mountain belt rising in terraces over the low land; and, *thirdly*, an inland plateau of great elevation overtowered here and there by lofty peaks; and, in other places, rent asunder by deep fissures which gradually expand into cultivated wadis and wide luxuriant valleys, watered by streams which, according to the season, are sometimes ripling rivulets, at others impetuous torrents. The mountain belt, an almost alpine chain, stretches in one uninterrupted line from Yemen to the borders of Oman, where it diminishes in height; but no general name having ever been applied to it, that of the "Himyaritic chain" may be here suggested as not quite inappropriate. Beyond, that is to the north of, the high plateau, there is a sudden steep de-

scent into the sandy deserts of El Ahkaf. Wrede estimated the average breadth of the Himyaritic chain at 25 German, or 100 geographical miles; and its length being upwards of 1800 geographical miles, it apparently ranks among the great mountain systems in the world. In fact, its length is one-half of that of the Cordilleras of the Andes, twice that of the Ural, thrice that of the Alps and the Caucasus, and it seems to occupy an area of nearly 200,000 square geographical miles. The highest peaks appear to attain an elevation of 10,000 feet.

From Makallah, which was Wrede's starting point, the *akabah*, which means "ascent," and is the general name in Arabia for the rising portion of mountains, was very steep, till the traveller arrived on the first terrace. There the acclivity was interrupted by a narrow barren plain, followed by another akabah, which, in its turn, led to another terrace, and so on in regular succession, till the high plateau was gained. Here the nights were severely cold. The basis of this tract is granite, with its usual superstrata, heaved up and broken into wild chaotic masses, by volcanic action, of which the traces are so frequent and so visibly evident, as to lead to the surmise, that there are still active volcanoes somewhere in the country, having the same common hearth with those which are still in activity in the islands, near the entrance of the Red Sea, and those which ceased to be so in Yemen. According to an Arabic legend, Yemen was separated from the opposite coast of Abyssinia by a tremendous earthquake, which caused the waters of the Indian Ocean to enter the Red Sea. Many thousands of people were drowned, and such were the lamentations of the survivors, that the new channel was called Babelmandeb, or the gate of tears. Primitive limestone forms chains of considerable length and elevation, as, for instance, along the wadi Maifah, the summits of which range between 4000 and 6000 feet in height. Jura limestone occupies large tracts, whence caverns with subterranean streams are frequent. Wrede entered one which was very capacious and deep, the vaults hung with beautiful stalactites, and the whole cavern resounding from the noise of a powerful stream rushing unseen through the bowels of the rock. But the natives fearing to irritate the *ghuls* or evil spirits, with which their superstition peoples these caverns, would not allow him to penetrate to the deeper recesses. Hot springs are frequent, and there is such a number of fissures and caves through which sulphureous vapour escapes, and the sides of which are so thickly covered with the finest sulphur, as to warrant the supposition that a large and profitable trade with that article might be established here, if the natives would allow the access to strangers, and there were roads in the country. The most celebrated among the sulphur caves is the Bir Bahut, through which, according to the natives, the souls of the damned go down to hell, in contradistinction to the crater in the island of Djebel Teir, in the Red Sea, through which the devil is said to come up from hell, when he is about to do mischief in the world. Bir Bahut is most probably the *Fons Stygis* of Ptolemy. In many localities, the steep rocks encompassing the wadis are quite perforated by such caves; and as they offer cheap habitations, and are above the level of the highest floods which fill the glens after heavy showers, half savage tribes of Bedouins have turned them into permanent dwelling-places for their families. As the traveller passed by, scores of swarthy children suddenly issued from the holes like rabbits from their burrows, to have a peep at the strangers. During the frequent absence of the inhabitants, the caves are watched by a race of very fierce dogs. The habits of the people having remained the same during thousands of years, it is but reasonable to believe that in ancient times also there was a troglodytic population in this part of Arabia, and that the statements, to that effect, of Ptolemy and other Greek geographers, are quite correct.

Volcanoes, caverns, and hot springs.

Troglodytæ.

Origin of wadis.

The Baron von Wrede compares the aspect of the country with its countless wadis, as seen from above, to a gigantic leaf divided into innumerable compartments by the network of its veins, the principal of which being the Wadi Doan, which bisects the tract from one end to the other. The wadis have their origin on either side of the crests of the hills, and on the high plateaux of those low ridges which interrupt the level. Their first beginning is an almost imperceptible rill, or a mere fissure in the sloping rock, which gradually widens, owing to the agency of water, and assumes the aspect of a narrow glen encompassed by two walls of perpendicular rock. If there are springs in its upper portion, there will be a permanent stream; if there is no water but that descending in sudden and heavy showers, in the rainy season, the stream will be transient; but in either case, the volume of water rushing down these gaps in the rainy months surpasses belief, and its velocity is so great, its rush so sudden and irresistible, that lofty and solid rocks, undermined at their base, will crumble into huge fragments, which the roaring flood carries downward, till, expanding itself over a wider space, it loses the power of its first impetus. In consequence of this never-ceasing activity of nature, the detritus and rubbish along the base of the rock-walls increases in width and height, in proportion as the wadi becomes wider; and it is on these slopes that the Arab begins the work of cultivation. In many localities, the upper portions of the wadis lie in deep gaps produced by volcanic action, while among the craggy rocks in the mountains between the table-land and the tehama, they do not differ from glens and valleys in other mountainous countries of a similar geological character.

Wadi Doan.

The head of the Wadi Doan is a deep gap in the centre of the barren table-land, upwards of sixty geographical miles north-west by north from Makallah. Nothing announces its approach; its palms, its houses, its turreted castles, its crystal stream and verdant plantations, lying, as it were, hidden in the bowels of the earth invisible to man, like the bottom of a precipice, till his eye merges over the upper edge, when the scene below bursts upon him like enchantment. A narrow, steep, and very dangerous path leads from the edge down into the glen, which is about 300 paces asunder, with a narrow belt of cultivated slopes at the base of the rock-walls. But the glen gradually widens, the rocks on either side losing their steepness and craggy aspect, till it expands into a fertile valley, measuring from 20 to 25 geographical miles across in its widest part. The direction of the Wadi Doan, the name being applied to the whole length of the valley, is at first north-west, then north-east, east, south-east, and south, when it issues upon the Tehama and Sihut, about a hundred geographical miles east of Makallah. Its whole length may be computed at 120 geographical miles, but only its upper course is known. Its head is the Wadi Minua, with a branch, the Wadi Nebbi; the next section is Wadi Doan, properly speaking; and the other parts are successively called Wadi Hadjarin, Wadi Kasr, and Wadi Missileh. This valley has many branches, most of which slope down from the high table-land to the south and west of it. Wadi Doan is studded with towns and villages from its very beginning, and the slopes, as well as the wider level tracts between the encompassing hills, are surprisingly well peopled and cultivated, the fields, or rather gardens, bearing rich crops of durra and other corn, dates, bananas, melons, cucumbers, indigo, and a variety of other vegetable products, of which considerable quantities are exported. The stream is not permanent, at least not in its upper course, where particular care is bestowed upon irrigation. During the sojourn of the Baron von Wrede at Khoreibeh, one of those awful thunderstorms broke out which have been alluded to above. It was still at a distance, and the clouds lowering over the town did as yet but threaten to discharge themselves, but they had evidently burst further up, when piercing cries of "The flood! the flood!" alarmed the inhabitants. Men, women, and children, were now seen running in haste and trepidation to gain their houses, which stand on the rising slope, when suddenly a tremendous body of water came roaring down the dry bed of the river, sweeping everything moveable before it, and threatening to annihilate the whole town. Cloud now burst upon cloud, and every voice and sound was drowned in the rush of the waters and the never-ceasing peals of thunder, while the narrow glen was shrouded in night, lit up every now and then by the transient blaze of the firmament. An hour thus passed away, when the sun again darted from a cloudless sky, and the flood was gone without causing any destruction; but all the canals of irrigation running parallel with the stream, and the numerous reservoirs and tanks, were overflowing with that precious gift of nature, without a constant supply of which, the inhabitants would be obliged to abandon this picturesque valley.

Bahr-es-Saffi.

At the foot of the Akabah, leading from the table-land to the desert El Ahkaf, there is a desolate district very much dreaded by the natives on account of a very singular phenomenon. It

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appears that in the adjacent portion of El Ahkaf, there is a great number of large, unfathomable pits or gulfs filled with quicksand, or rather a white, grayish dust, soft to the touch, and different in colour and substance from the yellowish and reddish sand of the desert. Whatever falls into such a pit disappears instantly. The gulf visited and examined by Wrede, was about a mile in diameter, and clearly distinguishable from above owing to its colour, by which its surface was set off against the darker desert. The Baron having been unable to persuade his Bedouin guides to follow him to "the mysterious abode of ghuls," cautiously approached the edge of the gulf provided with a plummet, weighing a kilogramm, and a line 60 fathoms long. Having thrown the lead as far over the edge as possible, it disappeared the moment it touched the surface, and continuing to sink, rapidly drew the line after it, till in a few minutes both plummet and line had disappeared, the latter having slipped through his fingers, which prevented him from drawing it back and making a second attempt. The Baron does not venture upon an explanation of this phenomenon, but there seems little doubt that these gulfs are extinct craters filled with some attenuated volcanic substance of a whitish colour, and similar to that which produces the far-seen white streaks on the volcano Djebel Teir in the Red Sea. The sand gulfs extend over a large district which is called Bahr-es-Saffi, or the Sea of Saffi, after a certain king, who, as the legend goes, ventured to cross this tract with his army, while contemplating the conquest of Hadhramaut, but was swallowed up by the sand-gulfs, together with the last of his men. The story reminds us of the fate of a portion of the army of Ælius Gallus. The only difficulty is the circumstance that this white dust remains on a stationary level, a little lower than that of the desert, and does not mix with the yellow sand of the common desert. As to the rest, large and deep volcanic craters hollowed out in the level plains of table-lands, are by no means of rare occurrence. Those in the Auvergne, in France, and in the Eifel, in Germany, being filled with water, are lakes in every sense of the word (Maare), but as there is no superabundance of water in the desert El Ahkaf, sand, of which there is more than sufficient, seems to have taken its place.

The whole Ahkaf appears to have once been the bottom of a great fresh-water lake, perhaps raised to a higher level by one of those tremendous volcanic commotions which have been so active in the formation of the surface of Arabia. Supposing, therefore, that the gulfs are craters communicating with great caverns in the earth, we presume that the water escaped through them while the rocky bottom of the lake was in progress of rising. The craters were subsequently filled up with the lighter particles of the desert sand, which, although of a general yellow colour, does not appear to be of a homogeneous nature, and in proportion as the sand or dust sinks into the earth, the water at the bottom carries it off into the bowels of the earth. Admitting this, the sucking qualities of the sand, and the equal level of its surface, to which local causes may also contribute, are easily accounted for. Admitting further the compound nature of the desert sand, it is evident that, once changed into quicksand by the action of water, the yellow particles, being derived from ferruginous sandstone, and consequently heavier, must necessarily sink through the lighter whitish dust; whence the uniform white aspect of these remarkable sand gulfs. The powerful springs in the wadis El Hajar, &c., which all burst forth on the south side of the plateau, and on a level considerably lower than that of the Ahkaf; the subterraneous stream in the Bir Ba Rahut; and the hot sulphureous spring near Sah Hud on the coast, are all, in the opinion of Wrede, connected with the mysteries of Bahr-es-Saffi.

Products.

The abundance of sulphur has been mentioned. The brownish or reddish colour of the level portions of the high tableland originates undoubtedly from the presence of an abundance of oxide of iron in the rock which has contributed to its formation. Traces of gold have been found in the south. There are numerous quarries yielding an excellent stone for building purposes, and there is no want of materials for burning good lime and making cement. The vegetable products are the same as in the rest of Arabia, a few species excepted. Indigo is extensively cultivated, but coffee not at all. The slopes of the Himyaritic range are covered with magnificent forests; the valleys are clothed with shady groves, and springs issuing from every fissure, give rise to a countless number of rivulets and rivers swarming with small fish. But the tableland, and in general all the plains, whether high or low, are barren and miserable. There are no cows in Hadhramaut, except a few near Makallah, which, however, are of the Indian species, with a hump on their back, like those in Yemen. Horses are very rare. The common beasts of burden are the ass and the camel, the former vying in beauty and usefulness with those of Bahrein and Oman, and the latter being equal to those in other parts of Arabia. The common belief that the camel is only serviceable in sandy plains, is not at all based on facts. On the contrary, the same camel which patiently wades through the burning sand of the tehama, climbs up the most rugged and dangerous mountain paths with a sure footing and a steady step. Sheep, and still more so goats, are very numerous, the latter yielding excellent milk. There is no want of antelopes, hares, and other game, and there are few beasts of prey.

Inhabitants, towns, houses.

Here, as elsewhere in Arabia, the natives are divided into two very distinct classes—the settled inhabitants living in towns and villages, and the wandering Bedouin. The former are nearly as civilized as in Yemen, less corrupted, but infinitely more fanatical. The prophet Hud is held in great veneration among them, and swarms of pilgrims annually visit the tomb of that mythological person, which stands in the lower part of the Wadi Doan. They call Hadhramaut a land sanctified by that holy prophet, undefiled by the foot of either Jew or Christian, and the unconquerable asylum of the true doctrine of Mahomet. The number of well-built towns, which are all fortified, is surprising, and the Wadi Doan is quite studded with them, presenting, in several localities, the curious sight of twin towns, each a separate town with its own walls and towers, and its own sheik, or even sultan, and only separated from the other by the narrow stream which waters the valley. The principal towns in the Wadi Doan are:—Grein and Khuairah, twin towns, with a combined population of 9000; Zhaher and Matrah, the same; Gelbuhn, 4000; Rashid and Arsameh, each 5000; Rhudaish and Rihab, each 6000. In Wadi Hadjarin, a branch of Wadi Doan, Meshed Ali (once a large place), and Es Seif, twin towns, total population, 6000; Gahdun and Sava, each 6000; Haurah, 8000. In other localities, Ghoraf, Borr, Tierbi, Agnab, Tsah, and Makallah, each about 6000; Terise, 10,000; Shibam and Terim, each 20,000 inhabitants. Some of these towns are governed by a sultan whose authority extends over a more or less extensive tract; others are governed by sheiks who are the lieutenants of the sultan, at least nominally. But they all, sultans, sheiks and townspeople, bow to the supreme rule of the Bedouins. The houses are mostly solid and lofty buildings, constructed with freestone, and so compactly assembled, that the towns occupy a comparatively small area. There is a brisk trade going on with native products and foreign importations, among which English manufactured goods, German cutlery, and Bohemian glass, as well as various Indian commodities, form no inconsiderable item. In this unknown part of Arabia, Wrede found the house of a sheik furnished with European chairs and tables manufactured at Bombay; and the owner, who had been in India, not only spoke English well, but had a small library in which Sir Walter Scott's "Life of Napoleon" was prominent. At a dinner given to the traveller by the sultan of Khoreibeh, sherbet was served up in an earthen vessel of Staffordshire manufacture, of a description, however, such as is not used for lemonade in Europe. The townspeople are very fond of going abroad, as traders, sailors, &c., some to the seaports in India, others to those along the Red Sea, and others to Egypt, especially Cairo, where they are numerous, and known under the name of Hadhrami or Doani.

Bedouins.

The Bedouins in Hadhramaut are very numerous, divided into a great number of clans, and exhibiting peculiarities of character and habits which distinguish them from their brethren in other parts. They are a fine, strong, and athletic race of people, equally capable of supporting the stifling heat of the tehamas, and, though half naked, the intense cold on the uplands. The laws of hospitality are so far respected by them, that a stranger once received among them, becomes, as it were, a sacred person whom they will protect and defend at the risk of their own lives. Clan feuds are frequent among them, arising generally from murder and the like causes of violence, which the kinsmen of the murdered are bound to avenge by killing

either the murderer himself, or one of his family; and, when none of these are to be found, one of his clan. This goes on by rotation, each party having its turn of taking revenge, till at last whole tribes rise against each other in hereditary feuds. Many tribes are confederated, so that not only their own people, but also strangers standing under their protection, are safe in each other's territory. Even a man against whom there is a cause of blood revenge, is safe from vengeance when under the protection of an ally of his persecutors. The Baron von Wrede having procured a protector, or *dakheil*, at Makallah, was well received by the man's clan, and on subsequent occasions found that the dakheil he obtained in the interior could, under all circumstances, be relied upon, although a considerable degree of firmness was always necessary on his part to support his protector's sense of duty against fear or temptation. The Bedouins profess to be Mahometans, but they care very little for a strict observation of the law of the prophet, pleading the still greater sanctity of the law of necessity, whence they will eat all sorts of unclean animals, such as snakes, lizards, and the like vermin, "because they are hungry, there is nothing else to be got, and the law of the prophet does not fill their bellies." Here, as well as in Yemen, there are many remnants of the ancient fire-worship, which was the prevailing creed in South Arabia previous to Mahomet; and the prophet Hud, who lived in an age so remote, and whose person is so completely mythologized that modern scholars have been tempted to identify him with Bacchus, is no less revered by those children of the desert than Mahomet himself. But the reformed creed of the Wahabys never penetrated into these mountains. The Bedouins of Hadhramaut are altogether the fiercest and rudest among all the wandering tribes of Arabia, and whatever is calculated to uphold and propagate that reckless and savage spirit, is more admired by them, and esteemed more worthy of imitation, than the precepts of a refined morality. A lad having deliberately shot his father, who wanted him to fetch some camels, and kicked him when meeting with disobedience, was not only not punished by the tribe, but applauded, and finally praised by his own dying parent, who, being in the act of taking revenge by shooting his son in his turn, suddenly dropped his gun, exclaiming—"No! let him live, he has acted like a man." The women of the Bedouins go about unveiled, and in the towns only married women hide part of their face, the young girls being allowed to exhibit their charms to the other sex without any other restraint but that of common decency. The Bedouins look upon the townspeople as a degenerated, cowardly, mercenary race, losing no opportunity of showing them their contempt; while, on the other hand, the settled, civilized Hadhrami speak of their wild brethren in the desert as a set of overbearing savages, and behave to them in a manner as the Byzantine Greeks did towards their conquerors, the Turks, cringing before their eyes, and cheating them behind their backs.

Language. The Arabic of Hadhramaut, especially that of the Bedouins, differs from that of Yemen, not only in pronunciation and accent, but also by the admixture of many non-Arabic words, which are, without doubt, remnants of the ancient Himyaritic. This latter language, or perhaps only a modified dialect of it, is still spoken in the interor of El Shehr or Mahra, and in all probability also in the eastern parts of Hadhramaut in the larger meaning of the word, but not along the sea-coast, where the modern Arabic prevails. The Baron von Wrede obtained a little vocabulary of Himyaritic words of the present vernacular tongue, among which the word "ofir," that is *red*, strikes the antiquarian at once, as being the key to the whereabouts of the Biblical "Ophir." For the Mahra people also call themselves the tribe of the *red* (ofir) country, and the same appellation they give to the Red Sea, which is but a translation of Erythrean Sea, which we are fully justified in supposing to be, in its turn, a translation of "Bahr Ofir." Other words, which are not found in the Arabic language, are:—*aïf*, bad; *diyah*, good; *fadhan*, hill; *gai*, *kin*, much; *kar*, house; *ebher*, well; *huf*, milk; *istaha*, sit down; *karhai*, small; *ket*, rope; *makedir*, durra; *rigau*, tall; *sami*, dead; *shikah*, near; *sheli*, very near; *salet*, oil; *sheiwat*, fine; *shiff*, hair; *tahrir*, antelope; *tahriz*, kill (him); *thama*, alive; *terab*, wood; *tobba*, great, powerful, &c.

Antiquities. The spirit of destructiveness which the Mahometan Arabs exhibited against whatever was not in accordance with, or left unmentioned in, the Koran, and their hatred of religious symbols, combined with an utter disregard of that historical learning which alone is calculated to keep alive, in the lapse of centuries, that feeling of piety towards the works of our forefathers, which is the real inexhaustible source of all love of antiquity, —these various combined causes have produced a sinister influence upon the monuments left by the kings and the nobles of Himyar. Yet some important remnants have been preserved, as shown by the researches of the travellers mentioned above; and the Baron von Wrede has not only added to the list, but leaves a fair prospect to future travellers of making still more important discoveries. At Khoreibeh he obtained a copy of an old Arabic MS., being a history of Hadhramaut from its earliest times, and containing a complete list of the Himyaritic kings from the founder of the kingdom down to Mahomet, corresponding with, and completing the list given by Abulfeda. In the Wadi Obneh, he copied a beautiful Himyaritic inscription of five lines, the characters of which seem to indicate Sabæan models; and he not only examined many substructures of modern buildings, which belong to a very early and primitive period, such as castles and houses of sheiks, but obtained positive information on the *Tulbet-el-moluk*, or the "tombs of the kings," in the lower part of the Wadi Doan, not far from Grein and the tomb of Hud. They are forty in number, each being a separate structure covered with Himyaritic inscriptions, and they are held in great veneration by the natives, although only a few even among their learned men know what they are. The Baron was prevented from visiting them by his arrest at Grein.

El Shehr or Mahra. The coast of this extensive province is now completely surveyed, but of the interior we know nothing. Much gum and frankincense, the latter of very ordinary quality, grows in the mountains along the coast, between Capes Ras Fartak in the west, and Ras Nus in the east. The tehamah is narrow, and in many places interrupted by spurs of the Himyaritic range projecting into the sea, as at Ras Fartak, the *Promontorium Syagrios* of the ancients, a bold rock rising 2500 feet above the Indian Ocean; and at Ras Shejer, which is still higher by 500 feet. The Himyaritic range lowers considerably as it advances north-east, some inconsiderable ridges of barren sand-hills being its extreme feelers towards the high mountains of Oman. West of Ras Nus is the fertile plain of Dhafar, where the cultivation of indigo occupies many hands. Dhafar, its former seaport, exists no longer; it was the seat of the bishops of Hadhramaut, when the Christian religion prevailed here in the period preceding that of Mahomet, and after they had left their former residence at Nagra, or Nagrane. East of the same cape Mr Cruttenden and party discovered the large, fertile, and well peopled Wadi Rekob, with a running stream dried up in its lower course, but which must be a powerful river in the rainy season, as testified by enormous blocks of rock carried down by the torrent from the mountains farther inland. The inhabitants are a remarkably handsome and well-disposed tribe, the women being the handsomest in Arabia, according to the statement of the British officers, their visitors. They have large herds of goats and sheep, and seem to lead a happy life as shepherds and agriculturists. In the upper portion of the Wadi Rekob lies a thriving town, Djezzar, which, however, the party had no time to visit. The inhabitants of the towns and villages along the sea, are addicted to piracy, for which they have been frequently punished by the British men-of-war; and they all pursue the capture of sharks, with which the sea swarms, and the fins of which, when salted and dried, are not only eaten by the Arabs, but yield an important article of export to the Indian ports and China, where they are considered great dainties.

Oman. Oman, the north-eastern peninsular projection of South Arabia, is physically hardly connected with the Arabian continent, from which its mountainous territory is separated by the eastern El Ahkaf. Its coast and seaports were known to the Europeans at an early date. Its capital, Mascat, was conquered by the Portuguese in 1508, who kept possession of it till 1658, when the Arabs, taking the town, put the whole garrison to death, and established a native government under a prince of the ancient dynasty of the tribe of the Yaharibi-el-Azad. The country was subsequently conquered by the Persians, who were driven out in 1730, in their turn, by Ahmed Ibn Said, an adventurous chief, who claimed collateral descent from that

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illustrious dynasty, and whose descendants still occupy the throne. The interior of Oman was first visited by the late Lieutenant Wellsted and his travelling companion, Lieutenant Whitelock, in 1835 and 1836; and although two years after them an enterprising French botanist, the late Aucher Eloi, made a trip into the inland district, the account of the British officers is still our main source of information. The north-eastern coast line against the narrow part of the Indian Ocean, opposite Beloochistan, is a serpentine curve 360 to 400 geographical miles long, extending from Cape Ras-el-Hadd, in the south-east, to Ras Musendom, in the north-west. The coast along the main of the Indian Ocean, in the south-east, is about 90 miles long; that along the Persian Gulf, in the north-west, about 150 miles; and the desert frontier, from sea to sea, in the south-west, about 300 geographical miles. A long range of mountains stretches from Ras-el-Hadd to Ras Musendom, almost parallel with the coast, and of which the central knob, the Djebel Akhdar, or Green Mountain, is the highest portion, rising to nearly 7000 feet. The height of Djebel Fellah and Djebel Hutah, in the south-east, is about 6000 feet; but the hills in the north are of less elevation. West of this range there is a barren plateau dotted with a great number of fertile and well-cultivated oases; the western edge of which forms another chain of mountains, less high than the main chain; and beyond this stretches the silent El Ahkaf. Beyond the desert, but where exactly we do not know, rises the Nedjed of El Yemamah, which is nearest to Oman in the north. The tract nearest to Ras-el-Hadd is called Djallan; west of it lies Oman proper, at the southern foot of Djebel Akhdar; west of Oman extends Dhorran, or the principal portion of the plateau, as far as the Persian Gulf, if the coast district is added to it. The tract extending north-west of Mascat, between the Indian Sea and the main range, is called Batra; it is intersected by numerous streams descending from that range; its soil is fertile, and well-cultivated, and its population may be called dense, as compared with the other provinces. The sea-shore is studded with towns and villages, but in the interior there is only one, but considerable town, namely Rostak, which was the residence of the reigning princes ere they took up their residence at Mascat. The southern portions of Oman are, on the contrary, very thinly populated, the soil being sandy; and as much may be said of the northern projection between the Persian Gulf and the Indian Ocean. The country produces wheat, maize, durra, and other grain, in great abundance; and besides the common fruit of Arabia, it yields indigo, cotton, sugar, and coffee. The latter article is not so good as the produce of Yemen, because not only less care is bestowed upon the plantations, but chiefly because its latitude is beyond the isotherm of the coffee-tree in Arabia and Africa, so that its growth would cease altogether, were it not for local causes. Irrigation is well understood: subterranean main conduits (feledj) four feet wide, with a running stream two feet deep, and from six to eight miles long, carry an abundance of water from the mountains into the drier plains. The camels and asses of Oman are justly celebrated. The breed of horses is excellent, but not numerous; the export of native and Nedjed horses from the port of Mascat, for the supply of the H.E.I.C.S. cavalry has of late much abated, the stock in the interior being almost exhausted. The same cause has affected the export of horses from El Katif, on the coast of Bahrein. The imam has several studs, the principal food being, next to barley, lucerne and dates. The cattle are of the Indian species, but although a large proportion of their food is said to consist of dried fish, the beef is tender and delicious to eat. The natives keep vast flocks of excellent sheep and goats; and there is an abundance of common fowl, but neither turkeys, guinea fowl, geese, nor ducks.

Divisions.

Inhabitants.

The relations between the settled inhabitants and the Bedouins are nearly the same as in Hadhramaut; the latter are a strong handsome race, and physically much superior to the tiny Bedouin of Nedjed. Their pursuits are pastoral and agricultural in the interior; but those who are near the sea are traders and mariners. The townspeople are much mixed with Persian and African blood.

Towns.

Mascat, the capital, counts about 40,000 inhabitants, and lies at the bottom of a small cove, in the gorges of an extensive pass which widens from this point as it advances into the interior. Its situation is picturesque, being surrounded by hills crowned with well-mounted fortifications, but its climate is sultry and unwholesome. It is next to Djidda the most important commercial town in Arabia, and its navigation extends over all the ports of Arabia, Persia, Africa, and India. The houses, except those near the beach, are but mean, the so-called palace of the imam not excepted. In its environs are the famous hot springs of Imam Ali. Contiguous to Mascat, lies Mattarah, or Mattrah, with 20,000 inhabitants, a seaport sharing in the commerce of the capital, with which it almost forms a twin town. The combined trade of these two ports is very important. Wellsted estimated the imports in 1836 at L.900,000, but they now are considerably above a million. They consist of manufactured goods from Great Britain and India; slaves, ivory, and other natural products from Africa; coffee from Yemen; salt, tobacco, and carpets from Persia, &c. The exports are fish, horses, grain, and other native products, and a large proportion of imported goods. Asses are exported to Persia and Mauritius. A new branch of export will open itself to Mascat, whenever it shall be thought fit to substitute the camel, as a hardy beast of burden, for the clumsy, easily-yielding draught-ox, in the colony at the Cape of Good Hope. Other towns are, along the coast, Sohar, with 9000 inhabitants, Sib, Burka, Khaburah, Shinas, Khadrawein, &c.; and in the interior, Rostak, a large town, Birket-el-Modj, the El Mal of Niebuhr, at the southern foot of Djebel Akhdar, said to be founded in the time of the great Nushirwan, king of Persia (A.D. 531–579), and remarkable for its lofty houses and two square watch-towers, 16 feet wide, and 170 feet high, the walls of which are only 2 feet thick at the base; Neswa, with a massive fortified tower, 140 feet high, surrounded by a like wall 40 feet high; Shirasi, in Djebel Akhbar, 5800 feet above the sea, in a lovely climate; Birema, in the north-west, 6000 inhabitants, with a like climate; and Obri, a large town quite in the west, and separated from Nedjed only by a narrow strip of desert. The northern peninsula has no places of note; but is remarkable for the narrow gloomy strait, leading through dark, perpendicular, and, in some places, overhanging rocks, from the Indian Sea to the Persian Gulf, between Ras-el-Djebel on the continent, and the island on which lies Ras Musendom, the north cape of Oman.

The imam of Mascat.

The most powerful prince in Oman is the imam of Mascat, Saiyid Said, who claims sovereignty over all Oman, but is only nominally obeyed by the settled population in the interior, and not at all by the Bedouins. In fact, the sheiks of Obri, Birema, and others, are quite independent. The title imam is only given to him by strangers and courtiers, since, of the two conditions necessary for obtaining that title, he has never fulfilled one, and has broken the other; that is, he has never preached a sermon before his assembled chiefs, and he has not only gone to sea, but is constantly sailing to and fro throughout his dominions. Although the latter condition has been dispensed with on previous occasions, the former is so imperative, that the natives withhold the title of imam from this powerful king, and only call him *saiyid*, or prince. Besides Oman, the imam possesses the islands of Kishm and others in the Persian Gulf; a large portion of the Persian coast which he farms from the shah of Persia, and where much bay salt is manufactured on his account; and the island and town of Zanzibar, on the East African coast, where he generally resides; as well as the town of Mombas and many others, with their respective territories, along the African coast. The imam, an ally of the British crown, is a sort of merchant prince, the principal part of the commerce and navigation of his scattered dominions being in his hands, and conducted on his account.

He is the mightiest potentate in those parts of the world. For the better keeping his scattered dominions together, he has a considerable number of men-of-war, of all sizes, which also serve as merchant-men for the conveyance of his own goods. In Wellsted's time, there were from 70 to 80 carrying from 4 to 74 guns, most of them small, but all built after European models, chiefly on the wharfs at Bombay. Besides these, there were from 60 to 80 armed bungalows, or one-masted Arabic vessels of from 200 to 300 tons, and balits, or smaller craft, of from 100 to 200 tons, which serve in the double capacity of convoy and transport vessels. To the late King William IV. the imam presented a fine 74-gun vessel, completely fitted out;

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and the value of the presents he made to Her Majesty Queen Victoria, on her accession to the throne, was estimated at L.50,000, being all articles grown in his own dominions, or manufactured by his own subjects. In 1845, Prince Hilal, the son and heir of the imam, visited London, accompanied by two young Arabic chiefs, and made himself much beloved through the courteous simplicity of his manners, and the amiability of his disposition.

It is expected that the friendship between the British government and the imam will be a great support to travellers intending to explore Central Africa from the side of Zanzibar.

History.

Arabia has been peopled from the earliest times, but its ancient history seems to have been lost or corrupted in a long course of oral tradition. The narratives of the Arabian historians are absurd and fabulous, resting on no evidence; nor have later writers succeeded in withdrawing the veil of oblivion from the history of those early ages. The common notion among the Arabs is, that they are descended from Joktan the son of Eber, as well as from Ishmael the son of Abraham by Hagar; and the posterity of the former are denominated pure Arabs, while those of the latter are called *naturalized* or engrafted Arabs. Joktan had thirteen, or, according to the Arabian traditions, thirty-one sons, who, after the confusion of languages at Babel, are said to have settled in the south-eastern parts of Arabia, and to have gone afterwards to India, with the exception of two, namely, Yarhab and Jorham, the former of whom gave name to the country. Yarhab settled in Yemen, while Jorham founded the kingdom of the Hedjaz, where his posterity reigned. Ishmael being dismissed by Abraham, retired to the wilderness of Paran, where he married an Egyptian, by whom he had twelve children, who were the heads of as many potent tribes of the *Scenite* or wild Arabs. He afterwards, according to tradition, married the daughter of Modad, the king of the Hedjaz, lineally descended from Jorham; and is thus considered by the Arabians the father of the greater body of their nation.[1] By these tribes Arabia was ruled in ancient times, and a genealogical list is preserved of a long line of kings in Yemen and other provinces, of whom nothing further is known than the names. The ancient tribes who inhabited Arabia maintained flocks and herds. They were addicted to commerce and rapine, and frequently by their inroads molested the neighbouring states. They were invaded in their turn by the Assyrians, the Egyptians, the Medes, and the Persians; but whatever ancient historians may relate concerning the victories of Sesostris, it does not appear that either the Assyrians, the Egyptians, or the Persians, ever obtained any permanent footing in the country.

The Greek and Roman writers describe with accuracy the general features of Arabia, the scarcity of water in the desert, the deep wells known only to the inhabitants, and the pastoral and predatory habits of the people; and, in the fertile districts, the rich produce of corn, wine, oil, honey, frankincense, myrrh, and odoriferous gums; but this information is mixed with fabulous tales and absurd exaggerations. From the rare and precious produce with which Arabia abounds, the most fanciful ideas were formed of its vast wealth. It was said to possess abundant mines of precious stones, and gold, which was found in small pieces of the size of nuts, of the brightest colour and polish. (Diodorus Siculus, *Hist.* lib. ii. sect. 48.) This favoured land was besides supposed to be enriched by the peculiar nature of its commerce, its valued products being sold to other nations, while their produce was not required in return. The balance of trade was thus always in its favour; and, according to this hypothesis, a supply of gold and silver was perpetually flowing into it from all other countries.[2] Cassia and cinnamon are also erroneously mentioned as the products of Arabia, probably because they came directly to the Romans from that country, which has been in all ages the great depôt of Indian produce. The great lake, mentioned by the ancient writers, and said to contain bitumen, and to yield a large revenue, must be the Dead Sea, thus included by the ancients within the limits of Arabia; or the existence of this sea so near Arabia may have given rise to the report of another lake in the interior, which we know does not exist. Pliny says that the inhabitants shave their beards, with the exception of the upper lip—a custom which, if it ever existed, has not been transmitted to the modern Arabs, who hold the beard in peculiar honour; and the story of their promiscuous cohabitation, related by Strabo and Ptolemy, is entirely contradicted by all the latest and most authentic accounts of Arabian manners.

In describing the zoology of Arabia, the ancient writers give an accurate account of the camel and the dromedary; but some of them assert that the country contains no horses, for which in modern times it has been so famed; and their description of the ostrich is altogether fabulous and absurd. Pliny asserts that it exceeds the height of a man on horseback; Diodorus, that it is of the size of a new-born camel, that it throws stones with its feet at its pursuers, and adds various extravagant and unfounded details of its habits and the manner of its death. Ptolemy was the first writer who divided Arabia into three parts; namely, Arabia Petræa, Arabia Deserta, and Arabia Felix; which division, agreeing with the natural features of the country, is still recognised. Ptolemy and also Pliny give a long list of towns, and of the various tribes which ranged over the country. The site of Petra, that splendid capital of Arabia Petræa, was rediscovered by Burckhardt, a silent necropolis in a deep, inaccessible wadi. The nations who inhabited this tract were the Ishmaelites, the Nabatheans, the Cedrei or Kedareni, and the Hagareni, all which appellations have in later times been lost in that of the Saracens, so celebrated for several centuries all over the East. Numerous towns are mentioned in Arabia Deserta, of which, being originally of little note, all knowledge is now lost; and of the tribes of the Æsitæ and the Agræi we know nothing but the names. Arabia Felix was the chief seat of population and of wealth. It included the fine provinces of Yemen, Hedjaz, Tehama, Nedjed, and Yumama. It was inhabited by many different tribes, such as the Sabæi, who from the account of Pliny were a powerful tribe, trading in frankincense, and extending from sea to sea, either from the Red Sea to the Indian Ocean, or to the Persian Gulf;[3] by the Minæi, Atramitæ, Marinatæ, Catabani, Ascitæ, Homeritæ, Sapphoritæ, Omani, Saraceni, &c., of whose history nothing is now known. The towns of Yaman or Yemen were, Aden, the *emporium Arabiæ* of Ptolemy, on the Indian Ocean; and Musa, the modern Mocha; both noted marts of trade, at which were exchanged the precious produce of the country (consisting of myrrh, frankincense, perfumes, and pearls, of which there was a noted fishery near some islands in the Red Sea), for goods brought by the annual fleets from India. Those goods appear to have been landed at Aden or Musa; to have been carried northward in caravans to Leucocome, or Portus Albus, in latitude 25° N.; then, according to Strabo,

[1] *Universal History*, vol. viii. chap. ix.

[2] Plin. *Historia Naturalis*, lib. vi. cap. 32. "In universum gentes ditissimæ, ut apud quas maximæ opes Romanorum Parthorumque subsistant, vendentibus quæ e mari aut silvis capiant, nihil invicem redimentibus." Strabo (lib. xvi.) mentions that they sold their gums for precious stones and for gold; and that the invasion of Arabia under Augustus, by Ælius Gallus, was prompted by the desire of attaining the alliance of rich friends, or the conquest of rich enemies. If these ancient writers had been versed in the modern doctrines of political economy, they would have known that the balance of trade could not have been permanently in favour of a country which abounds in gold.

[3] "Sabæi Arabum propter thura clarissimi, ad utraque maria porrectis gentibus." Plin. *Historia Naturalis*, lib. vi. cap. 32.

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to have been transported across the Red Sea to Myos Hormos, near the modern Cosseir; and being carried on camels to Coptos, in the Thebaid, a port on the Nile, to have been thence floated down in boats to Alexandria. Sanaa, the capital of Yemen, of great antiquity, is supposed to be the Saphor of Ptolemy; and Mareb, the modern Saba, which was a large, opulent, and strong city, is now an inconsiderable village. On the Persian Gulf was situated the port of Moscha, now the city of Mascat; and Gerra or Khatif, which, Pliny and Strabo mention, had turrets and houses formed of square masses of salt, some of which are still to be seen in the country. In the Hedjaz was Macoraba or Mecca, the seat of a very ancient temple; and Yathrib or Lathrippa, the modern Medina. Djidda, the port of Mecca, is seldom noticed by the ancients; and Yembo, the port of Medina, is the Jambia of Ptolemy. The frequent incursions of the Arabs into the neighbouring regions exposed them to retaliation from hostile armies; but the aridity of the country was ever found to be its true defence. It was in vain that the invader vanquished the Arabs in the field; they fled from his pursuit on their horses and camels, and quickly disappeared in the burning desert, whither no army ever dared to follow them. The northern provinces bordering on Syria were invaded by Antigonus, and afterwards by Pompey, though they never succeeded in acquiring possession of Petra, the great stronghold of the country. But the most important expedition of the Romans was that of Ælius Gallus, in the reign of Augustus, who, with a force of 10,000 troops, of whom 500 were Jews, and 1000 Nabatheans, natives of the country, landed at Leucocome, in latitude 25° N., about 70 miles north-west from Medina, and in the following spring, his troops having been till that time disabled by disease, he advanced southward, crossed a desert of 30 days' journey, and in 50 days more arrived in a pleasant and fruitful region, where he took by assault a city called Najran. He continued his march southward for other 60 days; and being finally compelled to retreat by fatigue and disease, he crossed the Red Sea, and, landing his troops at Myos Hormos, on the Egyptian shore, brought back the poor remains of his army to Alexandria, after an absence of two years.[1] The situation of the towns in his route being entirely unknown, we cannot trace his course, though it must have been in the direction of Medina and Mecca. The great historian of the Decline and Fall of Rome places the march of Ælius Gallus between Mareb or Mecca and the sea.[2] But this is a desert tract, in no respect resembling the character given of the country into which he penetrated, which may therefore probably be the elevated tract on the Hedjaz ridge of mountains, extending north and south parallel with the Red Sea. Northern Arabia was also invaded by the Emperors Trajan and Severus, but they effected no settlement in the country; and though the cities of Bosra and Petra were at one time reduced by a lieutenant of Trajan, yet the Romans never seem to have extended their power over Arabia Petræa. On the decline of the empire Syria was invaded by the Arabian freebooters, who sometimes drew on themselves severe retaliation. The doubtful frontier of the respective territories was thus a constant scene of hostility, until the Arab tribes, inspired by the genius of Mahomet, advanced to permanent conquests.

Jews were numerous in the Arabian seaports ever since the remote period when they monopolized the trade with Ophir and the spice countries on the Red Sea. After the destruction of Jerusalem, whole tribes of Israelites found an asylum in Arabia, where they became so powerful that Dunaan, a Jewish chief, succeeded in defeating and killing Er Riad, commonly called Aretha, the Christian (Arian) king of Himyar, in which country he assumed the royal power. But this Jewish kingdom did not continue many years, as it was conquered by Eleesbam, the Christian king of Abyssinia, who killed Dunaan. In the age of Mahomet, the Jews were very numerous and powerful in Arabia, and in spite of the persecutions which they had to suffer from him and his successors, there are even in our days great numbers of settled Israelites natives of Arabia, to be found in the seaports and wherever the fanaticism of the Arabs suffers them to dwell. In the interior Jewish tribes are met with leading a wandering life like Bedouins.

Mahomet.

Such are some of the early traditions and imperfect sketches of Arabian history. We now approach a new era, not only of greater certainty, but containing events of far deeper interest, and of lasting importance. The rise and progress of Mahomet, the prophet of the East, and the rapid propagation of his faith, which has changed the moral and political aspect of the eastern world, forms a most singular chapter in the history of human affairs, an account of which will be found under MAHOMET.

His death exposed the new state to the dangers of a disputed succession. The right to the throne, on which subject Mahomet was silent when he died, was respectively claimed by two powerful tribes, namely, those who fled to Medina with the prophet, or the *fugitives*, and those who aided him on his arrival, or the *auxiliaries*. To terminate this dangerous dispute, Omar, renouncing his own pretensions, held out his hand to Abubekr as his future sovereign; and his authority was recognised in all the provinces. The Hashemites, under Ali their chief, though averse to the new monarch, acknowledged him after some time as commander of the faithful. After a reign of two years he was succeeded by Omar, who was assassinated in the twelfth year of his reign, and was succeeded by Othman; and it was not till his A. D. 634. death that Ali ascended the throne. This contest for the dignity of caliph has ever since divided the Mahometans into the two hostile parties of the Shiites or sectaries, who reprobate as usurpers Abubekr, Omar, and Othman; and the Sonnites, who revere them along with Ali as the legitimate successors of the prophet. This schism is the source of the hatred which still exists between the Persians and Turks.

Arabia, during the reign of these several princes, was filled with distraction at home, while the most splendid conquests were achieved abroad. To give a detail of these events, which relate besides to other countries as much as to Arabia, would exceed our limits. We may therefore briefly observe, that during the short reign of Abubekr, the Syrian territories of the Greek emperor were overrun by the victorious Moslems under Abu Obeidah, and afterwards under Khaled, surnamed from his valour and fanaticism the sword of God; that the Greek armies were overthrown in several decisive battles; and that the rich and populous cities of the country, including Bosra and Damascus, were stormed by the barbarian invaders. A new army, raised by the Greek emperor, the last hope of the falling empire, was scattered before the barbarian host in the decisive battle of Yarmuk. Palestine was now subdued, and Jerusalem, which was reputed a holy city by its ferocious conquerors, and was visited by the Caliph Omar. Here he directed Amrou to invade Egypt, which was rapidly overrun; and his other lieutenants to complete the conquest of Syria. His orders were punctually obeyed, and Aleppo, Antioch, Tyre, Cæsarea, and all the other cities and fortresses in the province, A. D. 640. were successively taken.

On the east the empire of the Arabs was rapidly extended. "They advanced," says the eloquent historian of the Decline and Fall of Rome, "to the banks and sources of the Euphrates and Tigris; the long-disputed

[1] Dion Cassius *Hist. Rom.* lib. liii. sect 29.

[2] Gibbon, vol. ix. chap. 56.

Arabia. barrier of Rome and Persia was for ever confounded; the walls of Edessa and Amida, of Dara and Nisibis, which had resisted the arms and engines of Sapor or Nashir-
A.D 637. van, were levelled in the dust." The fate of Persia was decided in the great battle of Cadesia. The victorious Arabs poured like a flood over the country, and acquired prodigious spoil; nor did they halt in their victorious career till they had reached the banks of the Oxus, and had added to their empire Herat, Merou, Balk, Samarcand, and other rich and trading cities in the East.

The short reign of Ali, from the year 655 to 661, was disturbed by domestic dissension and the rival claims of Moawiyah, the son of Abu Sophian, well known for his tardy and reluctant obedience to the sword, as was alleged, rather than to the doctrines of the prophet. The death of Ali by an assassin was the signal for new contests. Moawiyah reigned at Damascus, which was the new capital of the caliphs of the house of Ommiyah, and was succeeded by his son Yezid A. D. 680, whose title was disputed by the surviving family of Ali, Hozein and Abdallah Ebn Zobeir, his two sons. They fled from Medina to Mecca; and Hozein was proceeding to Cufa on assurances of aid from the inhabitants, when he was surrounded and barbarously murdered, with all his followers, by Obeidallah the governor. Abdallah, the sole representative of the house of Hashem, was now proclaimed caliph at Medina, from which city he expelled all the adherents and dependents of the house of Ommiyah, to the number of 8000. Yezid dispatched a large force to their aid, by which Medina was taken, after a vigorous defence, and abandoned to pillage. Mecca, besieged by the army of Yezid, was on the point of sharing the same fate, when intelligence was received of Yezid's death. His son,
A. D. 684. Moawiyah II., succeeded him, and, after a reign of six weeks, died without naming a successor. Serious commotions now ensued. Merwan, of the house of Ommiyah, was proclaimed caliph at Damascus, while Abdallah reigned at Mecca. The former was succeeded by his son Abdalmalac, during whose reign the contest for the throne was terminated by the death of Abdallah, who, in a desperate sally from Mecca, where he was besieged by the troops of the rival caliph, was overpowered and slain. By his death the sovereignty was firmly established in the line of the Ommiades, who reigned in Damascus above 70 years.

But the title of this dynasty not being founded on any clear principle of religion or of law, was never recognised by the great body of the Moslems. They regarded with veneration the lineal descendants of the prophet, who on their part still cherished the hope of reigning over the Moslem empire. Numerous partisans of the line of Abbas were dispersed throughout the provinces, and secret plots for their restoration were gradually matured into rebellion. The last caliph of the line of the Ommiades was met on the field by a powerful army commanded by Abdallah, the uncle of his rival; and after an irretrievable defeat he escaped to Mosul, and finally to Egypt, where he was defeated and slain, and the last remains of his party extinguished. Amid the ruin and massacre of his family by the conqueror, a royal youth, Abdalrahman, alone escaped, and making his way into Spain, laid the foundation of a new dynasty of the Ommiades, who reigned in Cordova with great splendour for 250 years, from the Atlantic to the Pyrenees. In Egypt and Africa the Fatimite caliphs, the progeny of Ali, were invested with royal authority; and the new line of the Abassides transferring the seat of government from Damascus to the banks of the Euphrates, laid the foundation of Bagdad, the seat of their empire, and of wealth, literature, and science, for 500 years. Arabia.

In the course of these various revolutions and splendid conquests, Arabia, the original seat of the Mahometans, had dwindled into an inconsiderable province of their vast empire, and the rude inhabitant of the desert retained his solitary independence, heedless alike of distant victories as of domestic changes. The Hedjaz, the mountainous district of Arabia, and the chief seat of its commerce and its towns, was governed by the lieutenants of the caliphs,[1] or sherifs as they are called, who are chosen from the tribe of the Koreish, and who have always acted as the resident sovereigns of the country. But their power was unknown in the desert, where the scheiks still continued to rule. In the disorders attending the decay of the Mahometan power, Arabia was occasionally invaded by hostile tribes; but it was chiefly the outskirts of the country that were scathed by the flame of war, which never penetrated to the interior. It appears from the incidental and scattered notices which we possess, that about the year 1173 Sultan Saladin subdued a king who reigned in Yemen, and who had revolted against the authority of the caliphs of the line of Abassides. Having reduced the country, he committed the government to two deputies, who afterwards claiming independent power, were in their turn reduced by the troops of Saladin. In 1517, when Selim I. conquered Egypt, and extinguished the last surviving representative of the second dynasty of the Abassides, the sherif of Mecca brought to him the keys of the city; and the Arabian tribes professed their allegiance, and gave hostages as a pledge of their fidelity. The country continued under subjection for 50 years, when Muttahir, sherif of the kingdom, impatient of the Turkish yoke, attacked and routed the army of Murad Pacha, and freed the country for a time from its oppressors. A powerful army, commanded by the governor of Egypt, was dispatched by Selim II. to Yemen; the Arabian force was defeated and dispersed, and the authority of the sultan was re-established in Yemen, and extended backwards to the highlands. The country, thus reduced, was governed as a Turkish province by pachas sent from Constantinople. But in the interior the independent princes and scheiks still retained their authority, and continued to harass the Turks, and to drive them back to the coasts. They were expelled from the province of Yemen about the middle of the 17th century; and since this period until the invasion of the country by Mohammed Ali they have only possessed a precarious and nominal authority in the towns of Djidda and Mecca.[2]

The rise of the sect of the Wahabys, and the rapid Wahabys extension of their dominion and doctrines, forms a most important epoch in the more recent history of Arabia. These sectaries were the reformers of religion in the East. They were zealous followers of Mahomet, who were scandalized by the departure of modern believers from the simplicity of the faith; by their worship at the tombs of saints; by the luxurious ostentation of their dress; their remiss attendance at public prayers; the immorality of their lives; the scandalous indecencies which they practised in the holy temple of Mecca; and

[1] "Depuis ce tems-là (de Mahomet) les Arabes de l'Iemen (Yemen), et de toutes autres provinces de l'Arabie, sont toujours demeurés sous l'obéissance des Khalifs, ou de Bagdet ou Egypte, tant que le Khalifat a durée." (Herbelot, *Bibliothèque Orientale*, Iaman.)

[2] De Guignes, *Histoire des Huns*, tome i. livre vii. Cantemir's *History of the Growth and Decay of the Othman Empire*; Niebuhr, *Description de l'Arabie*. Hammer-Purgstall, *History of the Ottoman Empire*.

Arabia. finally, in opposition to the strict prohibitions of the Koran, by their free use of tobacco and other intoxicating drugs.[1] Such were the chief articles of the new creed, which, in the same manner as the faith itself, was propagated by fire and sword. Its founder was Mohammed-Ebn-Abd-el Wahab, the son of a scheik in an obscure village, born in the year 1691, whose history and success for nearly a century seemed to presage the final triumph of his doctrines and his arms. It is remarkable that the only two great revolutions which have ever taken place in Arabia have had their origin in religion. It was in both cases for religion that the sword was ostensibly drawn. The subjection or extinction of infidel tribes was a step in the progress of the pious work; and these objects being accomplished, the original design, however spiritual in its nature, necessarily terminated in conquest and political dominion. The young apostle of the new faith was trained in the strict principles of Mahometanism. He was sent to finish his studies in the university of Bassora; and on his return to his native village, commencing reformer of religion and of manners, he was banished by the governor. He took refuge in Derayeh, the capital of Nedjed, where he was protected by the scheik Mohammed-Ebn-Saouhoud, a zealous disciple, from political views, as was insinuated, of the reformed faith. Here the new tenets were embraced by crowds of proselytes, eager to draw their swords in the cause of truth; and so well did the Wahaby chief Saoud profit by their new-born zeal, that before his death in 1765 he had extended his faith and his dominion over the whole province of Nedjed. His son Abd-el-Azyz enlarged by new conquests the power of the Wahabys. He subdued and rendered tributary the surrounding tribes, threatened the holy cities, and finally spread the terror of his arms over all the northern parts of Arabia, from Mecca and Medina to Damascus, Bagdad, and Bassora. Mohammed-Ebn-Abd-el Wahab, the founder of the Wahaby sect, died in 1787, at the advanced age of 95. But this event noway damped the zeal of his followers. Their expeditions were dreaded all along the banks of the Euphrates, and in the neighbourhood of Bassora, which they invaded every year, committing great excesses, and massacring the Arab settlers who were the subjects of the Bagdad government. In 1797 the pacha of Bagdad undertook an expedition against Derayeh, the capital of the Wahabys. He was repulsed by Saoud, the son of the reigning chief, who continued his inroads into the Turkish territories on the Euphrates. In 1801 he stormed the town of Imam Hosseyn, where, according to the intolerant maxims of the new sect, 5000 persons were massacred.

Ghaleb, the sherif of Mecca, was alarmed by the conquests of the Wahabys, and since the year 1792 had been vainly contending against their rising power. In 1801 the sectaries invaded his dominions in great force. In 1802 they stormed the town of Tayf, which they gave up to a general massacre, in which neither men, women, nor children were spared. In 1803 the holy city, notwithstanding the brave resistance of Sherif Ghaleb, surrendered at discretion to the victorious Wahabys. On entering it, the strictest discipline was preserved by Saoud the chief, and not the slightest excess was committed. The inhabitants were, however, compelled to a more punctual attendance at prayers; to conceal their silk dresses; all their finely ornamented Persian pipes were collected before Saoud's house, and there committed to the flames; and the sale of tobacco was forbidden. Mecca was afterwards given up to the government of Sherif Ghaleb, on the usual condition of his conversion to the Wahaby faith. This conquest was followed by the reduction of the neighbouring tribes, and in 1804 Medina surrendered to the Wahaby arms. Here they rigorously enforced the duty of public worship; the absent were punished; and a respectable woman, accused of smoking the Persian pipe, was placed upon a jack-ass, and paraded through the town with the pipe suspended round her neck. Saoud soon after visited Medina, and carried away from the tomb of Mahomet all the valuable articles, namely, jewels and pearls, and Cufic manuscripts of the Koran, which it contained; and ordered his troops, according to the approved maxims of his sect, who reprobate the worship of saints, to destroy the cupola over the tomb; but it was so strong that with all their efforts they could not deface this curious relic of antiquity.

The Hedjaz continued to enjoy tranquillity during the years 1806, 1807, and 1808, under the divided rule of the sherif of Mecca and of the Wahabys, the power of the former gradually declining, while Saoud was acknowledged as pontiff and king over the greater part of Arabia. The Wahaby hordes extended their inroads southward into the mountains of Yemen, whence they descended to the coasts and plundered the towns of Loheia and Hodeida. On the north they advanced into the Syrian desert, and alarmed the Bedouins in the vicinity of Aleppo, as well as the inhabitants of Damascus, who had begun to send away their valuable property to the mountains of Libanus. The Mesopotamian tribes near Bagdad were attacked and pillaged; and in 1810 Saoud, at the head of 20,000 troops, stormed the Persian town of Kerbeleh, putting all the male inhabitants to the sword.[2] The regular intercourse of the great pilgrim caravans from Syria, Egypt, Persia, and Yemen, had been interrupted since the year 1803, and the few scattered pilgrims that reached the holy cities from the north and west generally came across the Red Sea from Cosseir to Djidda.

The surrender of Mecca and Medina to the sectaries, and the interruption of the pilgrimages, excited the shame and indignation of all pious Mahometans. Mohammed Ali, who in 1804 was appointed pacha of Egypt, received instructions from the Porte to undertake the reconquest of the Holy Land. He accordingly determined on the invasion of Arabia, and prepared an expedition which he committed to his son Tousoun Bey, and Ahmed Aga his treasurer. The infantry, amounting to 2000 troops, landed at Yembo from Suez in October 1811, and took the town after a slight resistance. In January 1812 Tousoun advanced against Medina; but he was assailed in the mountain passes, through which his route lay, by a powerful army of Wahabys, and utterly routed, with the loss of all his baggage and artillery. Being in the course of the summer largely reinforced from Egypt, he again advanced to Medina in November; and having sprung a mine and overthrown part of the wall, he carried the town by assault, massacring about 1000 of the garrison in the streets. The remainder, to the number of 1500, retired to the castle, which they afterwards surrendered on condition of receiving a safe conduct for themselves and baggage; in defiance of which they were, on quitting the town, treacherously massacred by the Turkish troops. Sherif Ghaleb, intimidated by the capture of Medina, now intimated his desire of surrendering the holy city to the Turkish commander. Mecca, with Djidda, its port, was accordingly taken possession of in January 1813 without any opposition; and in a fortnight the town of Tayf, which had been held by the Wahabys for sixteen years,

[1] Felix Mengin, *Histoire de l'Egypte sous le Gouvernement de Mohammed Ali*, tome I. p. 379.

[2] *Ibid.* tome I. p. 380.

surrendered after a feeble resistance.[1] In 1813 Mohammed Ali landed at Djidda; and on his arrival at Mecca, suspecting the hostile intrigues of Sherif Ghaleb with the Arab tribes, he caused him to be arrested and sent under a guard to Egypt. He was succeeded in the government of Mecca by Yahya, also of the sherif family, the humble tool of Mohammed Ali. In the mean time the Turkish army, weakened by its losses, remained at Mecca and Tayf; and, with the exception of an unsuccessful expedition against Toraba, the chief town of the southern Wahabys, and the capture of Gonfode, a port seven days' journey south of Djidda, which was soon after recaptured, no enterprise of any importance had been undertaken since the surrender of Mecca and Tayf. But Mohammed Ali was not idle. He employed the time in reinforcing his wasted army, in collecting magazines and stores, in purchasing camels, and in strengthening his influence among the Arab chiefs, many of whom he succeeded in detaching from the Wahabys by the influence of presents and money.

Saoud, the successful chief of the Wahabys, died at Nedjed in 1814, and his son Abdallah, who succeeded him, though he was brave, was inferior to his father in all the qualities of a political chief. The pacha having completed his preparations, now resolved to strike a decisive blow. In January 1815 he began his march southward in the direction of Toraba. The Wahabys, to the number of 25,000, occupied a strong position on the mountains near Byssel, from which, after some unsuccessful attempts to dislodge them, he contrived, by a feigned retreat, to draw them into the plain. Here their disorderly host was borne down by the steady attack of the pacha's disciplined force, and flying in confusion, they were cut down without mercy by the Turkish cavalry. A reward of six dollars being offered for the head of every Wahaby, 5000 of these bloody trophies were in a few hours piled up before the pacha's tent. Of 300 prisoners who were taken, 50 were, according to the cruel maxims of the East, impaled alive before the gates of Mecca, and the rest at other parts. Mohammed Ali hastened to profit by his victory. He arrived in four days before Toraba, which capitulated; and advancing southward, he encountered the wreck of the Wahaby army in the mountains near the town of Beishe. Here, after a brave resistance under Tamy, their chief, who was seen riding in front, animating the troops by his war songs, they gave way before the Turkish artillery. Tamy, who was betrayed into the hands of his enemies by an Arab chief, and by his gallant bearing gained the esteem of the whole army, was sent to Constantinople, where he was instantly beheaded. Another chief, Bakhroudj, was tortured to death in presence of the pacha. The Turkish army continued the pursuit of the Wahabys, and subdued most of the southern tribes. Mohammed Ali was intent on carrying the war into Yemen, whose rich cities he hoped to plunder; but the wasted state of the army forced him to an immediate retreat. He himself accordingly proceeded to Gonfode on the sea-shore, and arrived at Mecca on the 21st of March, after an absence of 15 days. Of his army, consisting of 4000 Turks, he brought back only 1500; and of 10,000 camels, only 300 survived the fatigues of the campaign.

The war against the northern Wahabys was prosecuted with vigour by Tousoun Pacha, who had advanced eastward from Medina to Khabara, about 300 miles into the interior of the country. Abdallah had fixed his head quarters at Shenana, only five hours' march from the Turkish army. Tousoun was here seriously embarrassed by the want of supplies. His treasurer Ibrahim Aga,[2] with a detachment, had been some time before surrounded on the road and cut to pieces, after a gallant resistance, and his remaining troops were averse to a battle. From these difficulties he was extricated by a peace, which Abdallah weakly concluded with him, and by which he agreed to renounce the possession of the holy cities, to be ranked among the faithful subjects of the sultan, to pray for him in the mosques, and to submit to his authority as his sovereign. But this treaty, however disgraceful to the Wahabys, was far from satisfying the views of Mohammed Ali, who, with his usual contempt of all engagements, refused to ratify it; and conscious of his strength, would enter into no overtures from Abdallah, however humble, having determined either to reduce or to exterminate the rebellious sectaries of Arabia of which he was the head. Both parties accordingly prepared for war. In September 1815 Ibrahim Pacha, son of Mohammed Ali, landed at Yembo with 2000 Turkish troops, besides 2000 peasants pressed into his service at Siout on the Nile, amid the outcries of their wives and children. He had also a corps of 500 Moggrebins from Barbary. Having spent some time at Medina in reducing the surrounding tribes, and visiting the holy sepulchre, he directed all the troops which could be spared from the different garrisons to march on Hanakye or Henakyeh, about 100 miles eastward of Medina, where, early in December, his whole force was concentrated. Here he remained till the end of April 1817; and though his troops suffered severely under fever and dysentery, the diseases of the climate, he succeeded, by several bold and well-concerted expeditions, in impressing on the Arab tribes the terror of his arms. He extended his alliances among them, and by his policy as well as by his arms he silently prepared the ruin of the Wahaby state. In the conduct of the war Ibrahim combined, with the cruelty of a Turkish conqueror, undaunted courage and skill, a rare perseverance under difficulties, and a fertility of resource which seldom failed him. The discipline of his troops secured his superiority in the field; and the Wahaby host, avoiding the risk of a battle, relied on their fortresses, the nakedness of the land, and the noxious climate. The issue of the war was thus reduced to a mere arithmetical question of the number of men that would be required to carry it on. These being provided, the conquest of the country was certain, and Mohammed Ali was too well versed in war not to see the advantages which he possessed, and too deeply interested to grudge the necessary supplies. He was willing to pay the fair price of his success. The army of Ibrahim, notwithstanding its losses, was accordingly maintained at its full complement by recruits from Egypt; and he now hastened to complete the conquest of the country by reducing its strongholds, and especially Derayeh, its capital. He had gone to the village of Maouyeh, where he was joined by a powerful chief; and having assembled all his forces, consisting of 4000 infantry and 1200 horse, besides his Arab auxiliaries, he advanced in July to the fortress of Rass. In three several assaults, conducted with desperate valour, but without skill, the assailants were overwhelmed, and finally repulsed with severe loss, by the well-directed fire of the

[1] Burckhardt's *Notes on the Bedouins and Wahabys*, p. 356–7. Mengin, *Histoire de l'Egypte*.

[2] Ibrahim Aga was a native of Edinburgh, named Thomas Keith, a private in the 72d regiment of highlanders, and taken prisoner in the last expedition of the English to Egypt. He became a mussulman, and on account of his valour was promoted to the high office of treasurer by Tousoun Pacha.

garrison; and Ibrahim, after vainly contending for three months and 17 days against the obstinate valour of the inhabitants, and incurring a loss of 3400 men, was forced to raise the siege of an ill-fortified place, which, with the aid of engineers, he might have reduced in two days. But this was the only disaster which befell the Turkish arms. The sequel of the campaign was one continued course of conquest. Khabra, Aneyzey and its castle, and Banneydeh, successively fell after a slight resistance. At the latter place the Turkish army remained for two months. Having received large reinforcements, it commenced its march, accompanied by a train of 10,000 camels and other beasts of burden, across frightful deserts of sands, and in January 1818 encamped at Chakra, which was taken after a siege of seven days. The town of Dorama was stormed after a brave resistance, and abandoned to pillage and the sword; and on the 22d of March, Ibrahim directed his victorious march to Derayeh, the capital, and last stronghold of the Wahaby state. This place, which consists of five small towns, each surrounded with a wall protected by bastions at small distances, was now closely besieged by the Turkish army, which, including infantry and cavalry, amounted to 5500 troops. The siege was long and obstinate, but the Turkish troops still maintained their superiority. The different divisions of the town were successively stormed; and the unfortunate Abdallah, thus driven to his last retreat, was reduced to ask a suspension of arms and a conference. His interview with Ibrahim presented a touching spectacle of fallen dignity. He demanded peace: the conqueror granted his request, but added that he was not authorized to leave him at Derayeh,—the positive order of his father was that he should repair to Egypt. Abdallah, after 24 hours of deliberation, intimated his assent to the proposed terms, and only conditioned for his life. Ibrahim would not answer for the decision either of his father or the sultan, farther than that he thought them both too generous to take his life. Abdallah, having bidden a last adieu to his afflicted family, repaired to the tent of Ibrahim, from which he set out on his journey across the desert, and arrived at Cairo. He was sent to Constantinople, where, notwithstanding the intercession of Mohammed Ali, he was beheaded, along with his companions in misfortune, in the square of St Sophia, after being exhibited in every part of the city for three days. With the death of Abdallah terminated the dominion of the Wahabys, which, under a succession of vigorous and politic princes, had in the course of a century been extended over the whole peninsula of Arabia. But their empire, loosely held together by the tenure of recent conquest, was overthrown by the first attack to which it was exposed. The chiefs who yielded to the terror of the Wahaby arms, deserted on the first appearance of a hostile army; others were seduced by the influence of gold, which was liberally distributed; and domestic dissension coming in aid of foreign war, dissolved the union of the tribes, and completed the ruin of the country. According to M. Mengin, whose information is undoubted,[1] Arabia had ample means of defence, in the difficulties of the country, and in the numbers, intrepidity, and discipline of its troops; and, with an able leader, he expresses his strong and apparently just conviction, that the Turkish army, in place of conquering the country, would have perished in its burning deserts.

The ruin of the Wahabys is deeply to be regretted, as it may throw back for several centuries the civilization of Arabia. The Wahaby princes reformed the morals as well as the religion of their country. Under the reign of Saoud the administration of justice was rigid and impartial. The crimes of rapine, thieving, and murder, so common among the Arab tribes, were severely punished; an exact police was established throughout the country; and caravans and travellers were seen journeying on all the roads in perfect security. The Turkish conquests will restore the primitive barbarity of the Arabian manners, and anarchy and crime will resume their wonted sway. But Arabia contains within itself the seeds of independence. The distance of Nedjed from Cairo, and the expense and difficulty of sending supplies through the interior deserts, will render it extremely difficult to maintain a Turkish force in the heart of the country; while the religious principles of the tribes, their warlike character and love of freedom, animating them to new efforts, may yet enable them to triumph over the foreign tyranny which oppresses them, and to re-establish their freedom on a new and a more secure basis.

The expeditions of Mohammed Ali against the Wahabys of Assyr, between 1824 and 1827, and again in 1833 and 1834, led to no lasting advantage for the Egyptian power. Since then, there have been frequent gatherings of the Wahabys in various parts of the peninsula; and there can be no doubt, that, should the decline of the Turkish empire continue, those intrepid and persevering reformers of a decrepit religion will ere long recover their former power. Only a few years ago, in 1850, they made a successful attempt upon Mecca and Medina, conquered both cities, and occupied them for a considerable time.

(D. B—N.) (W. P—E.)

ARABICI, a sect which sprung up in Arabia about the year 207, whose distinguishing tenet was, that the soul died with the body, and also arose again with it. Eusebius (lib. vi. c. 38) relates that a council was called to stop the progress of this rising sect; and that Origen assisted at it, and convinced them so thoroughly of their error that they abjured it.

ARABISM, ARABISMUS, an idiom or manner of speaking peculiar to the Arabs or the Arabic language.

ARABIST, a person curious and skilled in the learning and language of the Arabians: such were Erpenius and Golius. The surgeons of the thirteenth century are called *Arabists* by Severinus.

ARACAN. See ARRACAN.

ARACHIS, a genus of plants of the natural order Leguminosæ. The only known species is *A. hypogæa*, much cultivated in warm countries, and known by the inappropriate name of *Earth-nut*. It grows in sandy soils in southern Europe, in Africa, and Asia. The seeds contain a bland oil, and taste like sweet almonds.

ARACHNE, in *Fabulous History*, a Lydian maiden who is said to have been the inventress of spinning. She is fabled to have been so proud of her skill in this art as to challenge Minerva to compete with her. The goddess, inflamed with jealousy, struck Arachne and tore her work, upon which she hanged herself in despair. Minerva, from compassion, brought her to life, and transformed her into a spider, which still employs itself in spinning.—Ovid, *Met.*, vi. 1–145.

[1] M. Felix Mengin landed in Egypt with the French expedition under Buonaparte. He remained in Cairo for 20 years after the country was evacuated by his countrymen, where he collected much valuable information respecting the internal administration of Egypt and the Wahabys. His account of this Mahometan sect is derived from the grandson of Ebn-Abdul-Wahab, its founder.

ARACHNIDES,

FROM ἀράχνη, a *spider*, and εἶδος, *resemblance*, a class of invertebrated animals, formerly regarded as true insects, and as such classed by Linnæus in his order Aptera, under the generic names of *Phalangium*, *Aranea*, *Acarus*, and *Scorpio*. The Arachnides were first formed into a distinct class by M. Lamarck, whose arrangement of the Linnæan Aptera is admitted by Latreille to approach the most nearly to the natural order.

The third primary division in the system of Cuvier, that of the articulated animals (*animalia articulata*), contains four great classes, viz. ANNELIDES, CRUSTACEA, ARACHNIDES, and INSECTA. We have already stated our intention (see ANIMAL KINGDOM) to treat of the first of these classes under the title of Helminthology, of the last under Entomology, and of the two intermediate classes in the order of their alphabetical occurrence. We shall therefore now proceed with the history and classification of Arachnides.

The naturalists who preceded Lamarck appear to have confounded this class either with the true Insecta, or with the crustaceous tribes, such as crabs and lobsters. It was in the course of his public lectures (in 1800) that the last-named observer instituted for their reception a separate class, under the title which they now bear.

Cuvier, in one of his earliest works (*Tableau Elémentaire de l'Hist. Nat. des Animaux*, 1798), continued, with his contemporaries, to class the Arachnides with insects, of which he regarded them as forming the third principal division, preceded only by the Crustacea and Myriapoda; thus far departing from and improving the old Linnæan system, by assigning them a higher place in his general arrangement, but not yet admitting them to the honour of a separate class.

Lamarck published the first edition of his *Système des Animaux sans Vertèbres* in the year 1801, and he there explains the reasons which induced him to form the separation previously advocated in his lectures.

M. Latreille did not admit the *classic* separation of the Arachnides, either in his *Histoire Naturelle de Crustacés et des Insectes* (1802–5), or in his later work, the *Genera Crustaceorum et Insectorum* (1806–7), but merely placed them at the head of the class of insects. In a subsequent volume, however (*Considérations Générales sur l'Ordre Naturel des Crustacés*, &c. 1810), he practically admits the propriety of M. Lamarck's views; and in it we find the Arachnides forming a separate class, and constituted of the same materials as those used by his predecessor. In that portion of Baron Cuvier's *Règne Animal* (vol. iii. 1817) of which M. Latreille is the author, we find the same arrangement followed, with this exception, that in the last-named work the Myriapoda and Chelopoda are removed from the Arachnides and placed at the head of the class Insecta—a modification likewise adhered to both in the *Familles Naturelles du Règne Animal* (1825), and in the recent edition of the *Règne Animal* itself (1829), which contains the latest view of M. Latreille. By these, in as far as concerns our general principles of arrangement, we shall be chiefly guided in the course of this article; but we conceive it due to M. Lamarck to present our readers, in the first place, with a short statement of his opinions.[1]

He defines the Arachnides as follows: Oviparous animals, at all times provided with articulated legs,—not subject to metamorphoses, nor ever acquiring new kinds of organs. Respiration tracheal or branchial: stigmatiform openings for the entrance of the air. A rudimentary heart and circulation in the greater proportion of species. Copulationes plures per vitam in plurimis.[2]

It is known that no vertebrated animal provided with feet has ever more than four; and that among such as are invertebrated, those which in a state of complete development are provided with feet, have never less than six. Amongst invertebrated animals, insects have essentially the smallest number of feet; for the various orders and families of that class, when arrived at their final development, have never more than six. They are hence called *hexapods* by some modern writers. It is otherwise, however, with the Crustacea and Arachnides, the greater proportion of which have more than six feet. Certain species, in their earliest state, have no more than that number; but their other feet appear as they advance in age. A few are hexapod, or six-footed, during the entire term of their existence; but in addition to those characters which determine the class to which they belong, various other relations connect them with their congeners, and show that they are not genuine insects.

Among those articulated animals which possess no system of circulation, insects alone undergo genuine metamorphoses; and none of the Arachnides are subject to such changes. Now, as all Arachnides are essentially distinct from the Crustacea, and as they differ from insects in the important characteristic just mentioned, it follows, according to M. Lamarck, that they constitute an assemblage of beings which ought not to be held in separation, however diversified they may be in various points of their organization.

The most remarkable circumstances in the structure of Arachnides are the following: That while many of these creatures are obviously provided with a circulating system, others present no vestige of that system; that the former breathe by means of branchial cells, while the latter respire through tracheæ; and that certain tribes are provided with antennæ, and others are entirely destitute of any such organs. These apparent non-conformities of structure result from this, that throughout the extended course of their class, the organization of the Arachnides undergoes rapid and remarkable changes; and if in the course of our observations we were to attend not only to the differences of external or internal parts, but to the progress of nature in the order of her productions, we would sooner perceive the propriety of that succession or change of organization even among animals really allied to each other by the great majority of their relations; and it would not have been deemed necessary to remove to another class such of the Arachnides as were antennated, because it would have been then more clearly perceived how incompatible was such a change with the assignment of their natural and appropriate place in the system.

[1] See the *Histoire Naturelle des Animaux sans Vertèbres*, 7 vols. 8vo. Paris, 1815–22.

[2] "Animalia ovipara, pedibus articulatis in omni tempore instructa, ad metamorphoses non subjecta, nec nova partium genera acquirentia. Respiratio trachealis aut branchialis: orificiis pro aeris intromissione stigmatiformibus. Cor circulatioque in pluribus inchoatis. Copulationes," &c. *ut supra*.

The class of Arachnides, as established by Lamarck in his *Cours*, contained five or six small families, which, though each possessed of particular characters of distinction, it would have been difficult to separate from their common frame-work, without considerable inconvenience to whatever other class one or more of such families might have been removed. If, for example, the antennated Arachnides should be classed among insects, we then destroy the most simple and satisfactory definition which can be given of the last-named class, while we are forced to assign to the animals with which we unite them a position in the general series unsuitable to their real nature and attributes. If we transport the tracheal Arachnides to the class Insecta, in order to enable us to define the latter class by the exclusive character of respiring by tracheæ, then insects can no longer be said to be uniformly distinguished by the possession of antennæ, and the genus Phalangium, &c. would be separated from the class which contains the spiders. For these reasons Lamarck is of opinion that the division which contains his Arachnides, whether antennated or non-antennated, ought to be preserved in its integrity, if we wish to avoid the impropriety of associating with insects other forms of animal life which nature has distinguished by different characters.[1]

A class may be constituted of natural materials, and contained within suitable limits, and nevertheless present among its various families animals of very different forms and construction. During every period of its existence, a butterfly presents an aspect very dissimilar to that of a scarabæus, yet both belong to the true Insecta. When strong general affinities (*analogies d'ensemble*) prevail, those special diversities of structure which are occasionally observable are insufficient to authorize a separation of classes. The genera Aranea, Phalangium, and Galeodes, are very nearly related to each other, although the first respire by obvious branchial cells, while the others enjoy a tracheal respiration.

The non-antennated Arachnides are in general provided with eight feet; and the Acarides and Pycnogonides conduct naturally to the Phalangides, such as the genus phalangium and others. Now, if these Acarides belong essentially to the Arachnides, can the parasitical genera, such as Pediculus and Ricinus, which lead towards them so evidently, be regarded as belonging to another class? The transition is so gradual and prepared, that the Acarides, provided for the most part with eight feet, like the other non-antennated Arachnides, yet present us with many genera (such as Astoma, Leptis, Caris) which have never more than six. Lamarck maintains the necessity of preserving the class Arachnides according to the limits which he has himself assigned to it, because its being so preserved relieves the class of insects from species with which that class has little or no connection. Without citing the impossibility of assigning a suitable position among insects to tribes like the Parasites, the Thysanoura, and the Myriapoda, the strongest objection to the reunion of these animals with insects is, that it will alter the general and truly natural characters assigned to the latter, viz. that of presenting, after exclusion from the egg, a particular state of *larva*, singularly varied according to the different orders in the forms and parts of the animal, and that of finally exhibiting an *imago* or perfect state very different from the larva, and distinguished by six articulated legs, two reticulated eyes, and a pair of antennæ.

Arachnides, on the contrary, although in many instances antennated, and, like all other living beings, undergoing successive developments of parts from the period of their birth, yet offer not the condition of a larva distinct from that of the perfect state: they preserve, not of course the dimensions, but the form and proportions of the parts with which they were originally produced; and if a few of them acquire additional parts in the course of their development, these are not of a new kind, but merely supernumerary to such as previously existed; for example, a pair of feet, or another segment to the abdomen. But this kind of development is different from that called metamorphosis in insects. All of these acquire either a new form, or parts of structure of a different kind from those which they possessed when first produced from the egg; and their state of larva, manifestly distinct from that of the perfect insect, is never equivocal.

Thus the Arachnides of Lamarck, distinguished in a general point of view from true insects by the want of metamorphoses, yet breathing in air, are remarkable for the singular gradations which their organization presents us when we compare the different families with each other. In fact, these animals exhibit, in their totality, different groups, which offer among themselves such great dissimilarities of organization, as might almost furnish the materials of as many classes; but such a proceeding would injure the simplicity of systematic arrangement, and would be unsuitable, in as far as these great divisions might still be connected together by characters of general application, the same, in truth, as those by which the class of Arachnides is itself distinguished.

Although certain Arachnides possess organs adapted to a circulating system, they do not on that account belong to the crustaceous class. They are chiefly distinguished from that class by their respiratory organs, which, whether tracheal or branchial, are always placed in the interior of the body, whilst in the Crustacea they are external. In the former, also, the opening which admits the fluid to be respired is stigmatiform; but it is not so in the latter.

Even the structure of the eyes affords an index to the Arachnides. All true insects have two eyes, with plane facettes, presenting the appearance of a very delicate network; but in the Arachnides the eyes are smooth, whether isolated, as among the greater number, or grouped as in spiders, and form a small mass, of which the surface is granular or sub-granular, and not in facettes. Arachnides form a class superior to insects, because many of them are more highly organized, and all of them are more nearly allied to the Crustacea than genuine insects. It does not follow from this that all the individuals of that class are superior to the most perfect insects, or that they have derived their existence, according to the French phraseology, by transition from these last-named creatures, or by an advance or progression in the scale of organization. For in the progress of animal life from the lower to the higher groups, the Arachnides appear to commence almost at the same epoch as the genuine insects, and present a dichotomous or double ramification, corresponding in its level with that which bears the entire class of insects. About that same point of the animal kingdom there seems in fact to be three distinct streams or courses of life, immediately succeeding the Epizoaria, viz. that of the apterous insects (*Pulex*), which leads successively to all the other forms of insect life; that of the antennated parasitical Arachnides (*Pediculus* and *Ricinus*), which leads to the Acarides and other non-antennated Arachnides; and that of the wandering (*vagabundæ*) antennated Arachnides (Thysanoura and Myriapoda), from which the crustaceous tribes may be said to spring.[2]

[1] *Animaux sans Vertèbres*, tome v. p. 6.

[2] *Ibid.* tome v. p. 10.

Thus, of those great divisions which appear to derive their origin almost from the same point in the scale, the first is formed of an enormous series of animated beings, characterized by the strongly contrasted aspects of larva and perfect insect; and the others are true Arachnides, and consequently present no such marked distinction between the conditions of the young and old. In the most perfect of the arachnidean class, such as spiders and scorpions, Cuvier has demonstrated a muscular and dorsal heart, subject to sensible systole and diastole; and on the abdomen he discovered several stigmatic openings (from two to eight), which lead to an equal number of particular purse-shaped cavities, each of which contained a great many small and very delicate laminæ or plates. These isolated cavities, and the plates with which they are filled, are without doubt the respiratory organs of these Arachnides. Cuvier regards them in the light of lungs; while Lamarck himself is inclined to view them rather as branchial cavities analogous to those observable in the leech and earth-worm—the property of branchia being, in the first place, the power of becoming habituated to the respiration of air (water being their usual medium), whilst the true lung respires air alone; and, in the second place (and this character applies of course *a fortiori* to lungs also), never to exist except in animals which are possessed of a circulating system.[1]

Finally, from the dorsal heart already mentioned two large vessels derive their origin, and are then ramified over the membrane of the respiratory cavities. Cuvier regards these vessels as pulmonary, the one acting as an artery, the other as a vein—and other vessels spring from the same dorsal trunk, and distribute themselves to various parts of the body. In these animals there is even a liver, composed of four pair of glandular clusters, which discharge their fluid at four different points of the intestine.

It is among the Arachnides that we find the first establishment of organs for the circulation of the animal fluids; and in the same class we perceive, as it were, the termination of tracheal respiration by ramified tracheæ, with a view to the substitution of the branchial system, which, though in itself admitting of considerable variation, is always characterized by its more local restriction. Among the Arachnides also we find the commencement of the principal of the conglomerated glands.

The respiratory sacks, which Cuvier pointed out in the spiders and scorpions, were also detected by M. Latreille in the genus Phryna, in such a manner as to connect, by that dominating feature in their structure, the Arachnides *pedipalpes* and the Arachnides *fileuses* of that author. Although among the Phalangides the respiratory sacks have not yet become perceptible, yet the aeriferous tracheæ have changed their character, and no longer consist of a double cord with a series of plexus, but are merely branched or ramified. The same order prevails among the Acarides, and results mainly from the reduced number and altered position of the stigmata. Among the antennated Arachnides, in which the stigmata are more numerous, and in general lateral, the tracheal cords, like those of insects, have as many plexus as stigmata; and such Arachnides, in fact, approach the most nearly to the class of insects. Thus tracheal respiration changes by degrees its nature and mode of action, as the stigmata undergo an alteration in regard to their number and position; and, becoming more and more reduced and restricted, it prepares the way, as it were, for branchial respiration, which only shows itself effectively along with the establishment of a circulating system. It results from these considerations that, in spite of the difference of organization observable in different families of Arachnides, these families are nevertheless related and united by natural affinities, which it is impossible to mistake, and would be improper to separate, and which appear to place them at an almost equal distance from Insects and Crustacea. In their aspect, however, they in general resemble somewhat more nearly the latter class. For example, the cancerides or crabs represent in some respects, by their short bodies, and heads confounded with the thorax, the usual form of spiders; while the cray-fish and Thalassinæ (*Cancer anomalus*, Leach) recall the figure of the scorpion.

The greater proportion of Arachnides dwell on the land, a few inhabit the waters, and a certain number are parasitical on the bodies of other animals, of which they suck the juices. In general they are carnivorous, and live on blood, or at least on animal substances; a very limited number existing on vegetable matter. Many are furnished with mandibles, which perform the functions of a trunk or sucker; and others are provided with an isolated or separate trunk, frequently accompanied both by mandibles and palpi. They are for the most part solitary animals, of gloomy habits, and forbidding aspect; they court concealment, and avoid exposure to strong light. The bite of many species is dangerous, in consequence of a poisonous or irritating fluid frequently instilled into the wound. The offensive organ in the scorpionides is placed at the extremity of the abdomen.

The following is a tabular view of M. Lamarck's system of arrangement.

General Division of Arachnides.

Order I.—*Antennated tracheal Arachnides.* Head furnished with two antennæ. Respiration effected by means of double-corded plexiform tracheæ.

Section I.—*Crustaceous Arachnides.* Two composite eyes, of which the surface is granular or sub-granular. They are sometimes called wandering Arachnides, to distinguish them from such as are fixed or parasitical. They are frequently of a scaly structure, and provided with mandibles fitted for incision and division. This section consists of two families, viz. *Thysanoura* and *Myriapoda*. The following are the genera of *Thysanoura:* Smynthurus, Podura, Machilis, Lepisma. Those of *Myriapoda* are, Scutigera, Lithobius, Scolopendra, Polyxenus, Julus, Glomeris.

Section II.—*Acarideous Arachnides.* Two or four smooth eyes. These animals are parasitical, and provided either with a retractile sucker or with two mandibles hooked for the purpose of adhesion. Their bodies are never scaly. The genera are Pediculus and Ricinus.

Order II.—*Non-antennated tracheal Arachnides.* No antennæ. Tracheæ for respiration branched, but not ganglionized. Two or four smooth eyes.

Section I.—Body either without apparent division, the head, thorax, and abdomen, being united in one mass, or composed of two divisions. This section is composed of two families, viz. *Acarides* and *Phalangides.* The former contains the following genera: Astoma, Leptus, Caris, Ixodes, Argas, Uropoda, Smaris, Bdella, Acarus, Cheyletus, Gamasus, Oribata, Erythræus, Trombidium, Hydrachna, Elais, Limnochares. The

[1] *Analyse des Travaux des Sciences de l'Institut pendant l'année* 1810.

genera of *Phalangides* are these—Trogulus, Siro, Phalangium.

Section II.—Body divided into three or four distinct segments. This section is likewise composed of two families, *Pycnogonides* and *Pseudo-scorpiones*. Of the first family the genera are, Nymphum, Phoxichilus, Pycnogonum; of the second, Galeodes, Chelifer.

Order III.—*Non-antennated branchial Arachnides.* No antennæ. Branchial cells or pouches for respiration. From six to eight smooth eyes.

Section I.—*Pedipalpi* or *Scorpionidæ*. Palpi very large, in the form of projecting arms, terminated by claws or pincers. Abdomen distinctly ringed, and not furnished with a spinning apparatus. Genera—Scorpio, Thelyphonus, Phrynus.

Section II.—*Araneides* or *Spinning Arachnides.* Palpi simple, in the form of small feet; those of the male bearing the sexual organs. Mandibles terminated by a movable crotchet. Abdomen without rings, and furnished at its termination with a web-making apparatus, consisting of from four to six spinners. Genera—Aranea, divided into numerous tribes or sub-genera; Atypus, Mygale, Avicularia.

In his *Considérations Générales*, M. Latreille founds the orders of the class Arachnides on two principal points as the first basis. These animals are either masticators or suckers. The jaws of the former are simple, and fitted for cutting and triturating the substances on which they feed; those of the latter, when they exist at all, serve only to seize their prey, and are terminated by a movable piece, either solitary and hooked, like a claw or crotchet, or accompanied by a fixed projection like a small finger. In the latter case the mandibles have the appearance of a pair of pincers. The Arachnides of this division compress with their pincers the small animals on which they prey, and so force the alimentary juices to pass by degrees into the œsophagus. The body of their prey having undergone this operation, is thrown aside. In spiders the claw of the mandible seems to execute an additional function. It distils a poisonous liquid, analogous in its nature to that which exudes from the mouth of the scolopendra, and the tail or sting of the scorpion. Moreover, all the masticating Arachnides are furnished with antennæ, while the suctorial tribes, with the exception of two genera, Ricinus and Pulex, are unprovided with these organs. Thus the primary divisions of this class by Latreille nearly correspond to Lamarck's two orders, the *Antennistes* and *Palpistes*.

M. Latreille then subdivides the masticating Arachnides into three orders—*Tetracera, Myriapoda*, and *Thysanoura*. The last alone present a thorax distinct from the abdomen, and have no more than six feet. In the two first-named orders the organs of movement amount at least to the number of fourteen, disposed along the sides of the body, each segment of which, with the exception at most of the last three, carry one or two pair. The Tetracera (genus *Oniscus* of Linnæus) are distinguished by four antennæ; there are only two in the Myriapoda. The Tetracera have besides several jaws, and are furnished with plates or foliaceous appendages on the inferior surface of the posterior extremity of their bodies The number of their feet is invariably fourteen. They are related in several particulars to the Crustacea. De Geer observed, that in Assellus and Idotea there is a kind of membranous cavity, frequently filled with air, beneath the plates of the tail; and similar parts are observable in the true crustaceous Squillæ of Fabricius. In Oniscus the air penetrates the body by openings, which are covered by the first folds of the tail. The other Tetracera probably receive it in a similar manner: at all events they are not provided with distinct external stigmata, like the Arachnides of the succeeding orders. We still find in this first division species which inhabit the sea; but as soon as we enter the order Acera (scorpions, spiders, &c.) we find none occurring in that element.

The structure of suctorial Arachnides is reducible to three principal forms or combinations of organs; 1*st*, Those possessed of antennæ, and of which the head is distinct from the thorax—*Parasita;* 2*d*, Those which are unprovided with antennæ, each segment of the body furnished with a pair of legs, and the head distinct—*Pycnogonides;* 3*d*, Those which are unprovided with antennæ, but of which the head and thorax are confounded as it were in a single segment, which alone is provided with feet—*Acera*. This last-mentioned order, according to Latreille, would form the first, if the organs of the mouth alone were considered, as these are more complicated than in any other suctorial Arachnides. The Acera have two palpigerous maxillæ, and frequently a lip, with two strong mandibles. The generality of the Pycnogonides have also mandibles, which have been taken for palpi, and true palpi, which have been erroneously regarded as antennæ; but their mouth consists of a tunnel or syphon of a single piece. It is still more simple in the Parasites, being nothing more than a very short projection, containing a small sucker, or a cavity of which the sides are dilatable, and accompanied by two crotchets.

In regard to the *families* of the Arachnides, the Tetracera offer two principal groups. Some dwell in salt or fresh water, are usually fixed upon other animals, of which they suck the blood, and have, with the exception of the genus Bobyra, four very obvious and distinct antennæ. They constitute the first family, that of *Asellota*. Others are more terrestrial than aquatic. They wander from place to place, love obscure and sombre situations, and live upon putrid substances; their two intermediate antennæ are but slightly developed. They form the second family, called *Oniscides*. According to Latreille, the structure of the mouth in Scolopendra is so different from that of Julus, that it is difficult to conceive the motive which influenced Fabricius to unite these Arachnides into a single order, that of *Mitosata*. In Julus, the maxillæ and the lip are soldered together, forming one transverse plate, without distinct palpi, or their place supplied by tubercles. The Scolopendræ have their maxillæ separated, four projecting palpi, and the labia in the form of hooks, subservient to the same uses as the mandibles of spiders. These considerations, and the figure of the antennæ, have required the establishment of two families, which compose Latreille's order Myriapoda, viz. *Chilognatha* and *Syngnatha*. Proceeding upon the same principles, he divides the order Thysanoura likewise into two families, the *Lepismenæ* and the *Podurellæ*. The next orders, Parasita and Pycnogonides, contain few genera, and do not admit of subdivision into families. The last order, Acera, is composed of eight families, viz. Scorpionides, Pedipalpi, Aranides, Phalangita, Acaridiæ, Riciniæ, Hydrachnellæ, and Microphthira.

Before commencing our systematic exposition of this class, we shall lay before our readers the sentiments of Mr Kirby. "I must next say something on the orders of the Arachnida. Every one at first sight sees that *spiders* and *scorpions* are separated by characters so strongly marked, that they look rather like animals belonging to different classes, than to the same. These form the two primary orders of the *Arachnida*, and they appear to be connected by two secondary or osculant ones,—on the one side by *Galeodes*, and on the other by *Thelyphonus* and *Phrynus*. This class, although there is an appearance of

eight legs, is, strictly speaking, of a *Hexapod* type; for the anterior pair, ordinarily regarded as legs, and performing their function, are really the analogues of the maxillary palpi of perfect insects. This will be evident to you if you examine any species of *Galeodes*. These animals, if we look at them cursorily, we should regard as decapods; but when we trace the two anterior pairs of apparent legs to their insertion, we find that both proceed from the *head*, which in that genus is distinct from the trunk; while the three last pairs, which alone are furnished with claws, are planted, as legs usually are, in the latter part. The first pair represent the ordinary palpi of *Arachnida*, are analogous to the labial ones of hexapods, and, as likewise in Phrynus and Thelyphonus, are more robust than what are usually taken for the first pair of legs; but they differ in being considerably longer, and, instead of terminating in a *chela*, are furnished with a retractile sucker.[1] The second pair are more slender and shorter than the first. They correspond precisely with what are deemed the first pair of legs of *Octopods* and *Arachnida*, and are clearly analogous to the maxillary palpi of insects. Whether the base of the first pair of these palpi is in any respect analogous to the labium of insects (as that of the second seems to be to their maxillæ), I am not prepared to assert; it will therefore be most advisable to name these palpi *anterior* and *posterior*; but as they evidently proceed from the head in Galeodes, and in that genus are clearly analogous to those of the Phrynidea (which in their turn as clearly represent those of the Aranidea), it follows, that in all they are organs of the part representing the head, and therefore not in a *primary* sense *legs*, although in a *secondary*, as M. Savigny[2] has proved, they may be so called."[3]

The following are the secondary groups of the class Arachnides, according to Mr Kirby's exposition, in the work last quoted.

1. Aranidea.—M'Leay. (*Aranea*, L., *Araneidæ*, Lat.) The Aranidea or spiders seem resolvable into two sub-orders—the *Sedentaries* and the *Wanderers;* thus forming, perhaps, what Mr M'Leay would denominate the normal groups of a circle of *Arachnida*.

   Def.—*Mandibles* armed with a perforated claw. *Head* and *trunk* coalite. *Palpi* pediform, anterior pair without claws. *Abdomen* without segments or elongated tail. *Spiracles* two. *Anus* furnished with an apparatus for spinning.

2. Scorpionidea.—M'Leay. (*Scorpio*, L. Latr.)

   Def.—*Mandibles* chelate. *Head* and *trunk* coalite. *Anterior palpi* chelate. *Posterior palpi* pediform. *Pectens* two. *Abdomen* divided into segments, and terminating in a jointed tail, armed at the end with a sting. *Spiracles* four pair.

3. Galeodea.

   Def.—*Head* distinct. *Eyes* two. *Mandibles* chelate, with dentated chelæ. *Palpi* pediform, the anterior pair thickest, with a retractile sucker. *Trunk* consisting of two principal segments, with a minute supplementary posterior one. *Spiracles* two, placed in the trunk. *Pseudo-pectens* two. *Abdomen* divided into segments. *Anus* unarmed, and without a spinning apparatus.

4. Phrynidea.

   Def.—*Mandibles* unguiculate. *Anterior palpi* chelate or unguiculate, very robust. *Posterior palpi* pediform, very long and slender. *Abdomen* divided into segments. *Spiracles* two pairs. *Anus* terminating in a mucro, and sometimes in a filiform jointed tail, without a sting at the end.[4]

In the *Règne Animal* (2d edition, 1829), Latreille includes in the class Arachnides only those species which correspond to the *Arachnides palpistes* of M. Lamarck. By this arrangement he is of opinion they may be classed and defined in a more simple and rigorous manner. According to his most matured views, then, the Arachnides, like the Crustacea, are destitute of wings, and are not subject to metamorphoses, but only to simple changes. Their sexual organs are removed from the posterior extremity of their bodies, and situated, with the exception of certain males, at the base of the abdomen. They bear a resemblance to insects in as far as the surface of their bodies present openings or transverse clefts named *stigmata*, for the entrance of air, but in smaller number than in insects (eight at most, generally two), and placed only at the inferior part of the abdomen. Their respiration is farther carried on either by aerial branchia, performing the office of lungs, inclosed in the cells of which the openings just mentioned are the entrance, or by means of radiated tracheæ. The organs of vision consist of small simple eyes, variously grouped when numerous. The head, usually distinct from the thorax, presents, as analogous to the antennæ of insects, two articulated appendages, in the form of small talons of two or more pieces, which have been improperly compared to the mandibles of insects, though moving in a different direction. They, however, cooperate in the action of the jaws, and are represented in those Arachnides of which the mouth is formed like a syphon or sucker by two pointed plates or lancets.[5] A sort of lip (*labium*, Fab.), or rather tongue, formed by a pectoral prolongation; two maxillæ, formed by the radical part of the first article of two small feet or palpi,[6] or by a lobe or appendage of that article; a beak-shaped projection, named sternal tongue (*langue sternale*) by M. Savigny, produced by the re-union of a very small chaperon, terminated by a minute triangular lip, and of a longitudinal inferior keel, usually hairy:—these, and the parts called mandibles, compose, under certain modifications, the general structure of the mouth in the class Arachnides. The pharynx is placed in advance of a sternal projection, which has been regarded as a lip; but when we consider its position behind the pharynx, and the absence of palpi, it is probably rather analogous to a tongue (*languette*). The feet, like those of insects, are generally terminated by two crotchets, sometimes by three, and are all attached to the thorax, which is almost always formed of a single articulation, for the most part intimately united to the abdomen. The abdomen in the greater proportion of species is soft, or but slightly protected.

When considered in relation to their nervous system, the Arachnides are obviously distinguished both from the Crustacea and Insects; for, with the exception of the scorpions, the ganglia or swellings of the nervous cords never exceed three in number.

The greater proportion of Arachnides feed on living insects, the bodies of which they seize or adhere to, and

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[1] Leon Dufour, *Six Nouv. Arach. &c. Ann. Gen. des Sciences Physiq.* iv. iii. 17, t. lxix. f. 7. b.
[2] *Mém. sur les Anim. sans Vertèbres.*
[3] *Introduc. to Entom.* vol. iv. p. 386. (1826.)
[4] *Ibid.* p. 388.
[5] *Chelicères* or *Antenne-pinces* of the French writers.
[6] According to Latreille, these do not differ from feet properly so called, except in the tarsi, composed of only a single joint, and usually terminated by a small crotchet; they almost entirely resemble the ordinary feet of the Crustacea

suck their juices. Others are parasitical on the bodies of vertebrated animals. A few, such as certain mites, feed on cheese, and on flour and other vegetable productions. In some of the species two of the feet are not developed till the animals have changed their skin; and in general it is not till after their fourth or fifth moult, or casting of their exuviæ, that the Arachnides attain to their completed state.[1]

The following tabular view exhibits the classification and relative position of the orders and genera of this extensive class.

CLASS ARACHNIDES.

ORDER I.—PULMONARIÆ.

FAMILY I.—ARANEIDES.

SECT. I.—*Tetrapneumones.*

Genus 1. Mygale.
2. Cteniza.
3. Atypus.
4. Erodion.
5. Dysdera.
6. Filistata.

SECT. II.—*Dipneumones.*

A.—Sedentariæ.

Tribe 1.—*Tubitelæ.*

Genus 7. Clotho.
8. Drassus.
9. Segestria.
10. Clubiona.
11. Aranea.
12. Argyroneta.

Tribe 2.—*Inæquitelæ.*

Genus 13. Scytodes.
14. Theridion.
15. Episinus.
16. Pholcus.

Tribe 3.—*Orbitelæ.*

Genus 17. Linyphia.
18. Uloborus.
19. Tetragnatha.
20. Epeira.

Tribe 4.—*Laterigradæ.*

Genus 21. Micrommata.
22. Senelops.
23. Philodromus.
24. Thomisus.

B.—Erraticæ.

Tribe 5.—*Citigradæ.*

Genus 25. Oxyopus.
26. Ctenus.
27. Dolomedes.
28. Lycosa.
29. Myrmecia.

Tribe 6.—*Saltigradæ*

Genus 30. Tessarops.
31. Palpimanus
32. Eresus.
33. Salticus.

FAMILY II.—PEDIPALPI.

Tribe 1.—*Tarentulæ.*

Genus 34. Phrynus.
35. Thelyphonus.

Tribe 2.—*Scorpionides.*

Genus 36. Buthus.
37. Scorpio.

ORDER II.—TRACHEARIÆ.

FAMILY I.—PSEUDO-SCORPIONES.

Genus 38. Galeodes.
39. Chelifer.

FAMILY II.—PYCNOGONIDES.

Genus 40. Pycnogonum.
41. Phoxichilus.
42. Nymphon.
43. Ammothea.

FAMILY III.—HOLETRA.

Tribe 1.—*Phalangita.*

Genus 44. Phalangium.
45. Gonoleptes.
46. Siro.
47. Macrocheles.
48. Trogulus.

Tribe 2.—*Acarides.*

Genus 49. Trombidium.
50. Erythræus.
51. Gamasus.
52. Cheyletus.
53. Oribata.
54. Uropoda.
55. Acarus.
56. Bdella.
57. Smaridia.
58. Ixodes.
59. Argas.
60. Eylais.
61. Hydrachna.
62. Limnochares.
63. Caris.
64. Leptus.
65. Aclysia.
66. Astoma.
67. Ocypete.

We shall now proceed to the first subdivision of the class into two great orders.

ORDER I.—ARACHNIDES PULMONARIÆ.

Characterized by the possession of pulmonary sacks, a heart with distinct vessels, and from six to eight simple eyes. The sacks contain aerial branchia, which perform the office of lungs, and are named pneumo-branchia by Latreille. They are placed under the abdomen, and are indicated externally by *stigmata* or small transverse openings, of which there are sometimes four on each side, sometimes only four in all, or two on each side. The eyes vary in number from six to eight,[2] whereas in the subsequent order (*Trachearïæ*) there are never more than four. The respiratory organ is formed of small plates. The heart is a

[1] Latreille has observed, in conformity with the experience of Jurine *fils*, that the *Argulus* of Müller does not acquire the faculty of generating till after the completion of the sixth moult. Caterpillars generally change their skins four times before they assume the form of the chrysalis, which, with the final transformation to the perfect state, causes the number of moults to amount also to six.

[2] The genus *Tessarops* of M. Rafinesque is described as having only four eyes; but M. Latreille is of opinion that the lateral pair had been overlooked.

large vessel, which stretches along the back, and gives off branches forwards and on either side.[1] The feet are constantly eight in number. The head is always confounded with the thorax, and presents two pincers (*mandibulæ* of authors, *chelicères* or *antenne-pinces* of Latreille) terminated by two finger-like projections, of which one is movable, or by a single hook or claw, always movable. The mouth is composed of a lip (*labium*); of two palpi, which sometimes assume the shape of arms or talons; of two or four maxillæ, formed, when there is only a pair, by the radical article of the palpi, and when there are four, by that same article and the corresponding portion of the first pair of feet; and of a languette of one or two pieces. If we were to assume as a basis the progressive diminution in the number of the pulmonary sacks and stigmata, then the scorpions which have eight, while the other Arachnides have only four or two, would form the leading genus of the class, and the family of *Pedipalpi* would take precedence of the *Araneides* or spinners; but these last-named Arachnides are to a certain extent isolated, by reason of the sexual organs of the male, by the hook of their frontal talons, by their pediculated abdomens, and the peculiarities of their spinning apparatus, as well as by their natural habits; and the scorpions also appear to form a more natural transition from the pulmonary Arachnides to the family of the pseudo-scorpions, the first of the second order.

Of all the Arachnides the *Pulmonariæ* exhibit the greatest analogies to the crustaceous class, especially to the genus Limulus and others of the pæcilopodous order. The pneumo-branchia and their stigmatiform openings may frequently be detected externally by yellowish-white markings, disposed in two longitudinal series. The first two are placed immediately beneath the sexual organs, at least in the females, at a small distance from the origin of the abdomen, and on its second segment, when that part is annular or divided into segments. Thus the second segment in these Arachnides corresponds in its characters to the first segment of the female Limulus. We may also perceive in them the indications of conglomerated glands, and even in certain species traces are observable of chiliferous vessels.

The claw of the mandibles in spiders, and the terminal joint of the tail in scorpions, form a species of dart, perforated by one or two openings, which give issue to a poisonous liquid secreted by special glands. This poison is mortal to such small creatures as form the natural prey of the Arachnides, and is even productive of dangerous consequences to man and the larger animals. Its mode of action on animals unprovided with a circulating system is not clearly understood, but the phenomena attending it might reasonably be adduced in support of that theory which advocates the agency of poison from the bite of venomous reptiles as being carried on as much through the medium of the nervous as the circulating fluid. The almost instantaneous death of animals from the bite of certain snakes has been regarded as a proof that the vascular system was not alone concerned; and the same sudden effect produced upon those classes in which, as far as we can perceive, no vascular system exists, demonstrates some other mode of action.

Notwithstanding the researches of Cuvier, Marcel de Serres, Leon Dufour, Treviranus, and other observers, our knowledge of the internal organization of several genera of Arachnides is extremely deficient. Hence it is difficult to trace the boundaries of the orders in a manner at once natural and precise. At the same time it has been remarked, that the accurate observation of the eyes and other external organs furnish characters which coincide with the distinctions deduced from internal structure, as far as the latter has been ascertained.

Family I.—Araneides.

This extensive family corresponds to the genus Aranea of Linnæus, and contains all those species commonly called spiders—the *Arachnides fileuses* of Latreille. The characters are, two or four branchial pouches; from six to eight simple eyes; last article of the mandibles (*chelicères*) in the form of a corneous claw, perforated at the extremity for the emission of poison, and folded upon the preceding joint; abdomen usually soft, without divisions, its extremity furnished with from four to six small teat-like appendages, pierced with numerous holes for the passage of the silk or spinning materials;[2] feet palpi, without pincers at the extremity, but terminated in the female by small hooks, and in the male by the generative organs. The maxillæ are never more than two in number. The languette consists of a single piece, always external, and placed between the maxillæ; its form more or less square, sometimes triangular or semicircular. The thorax, usually impressed with a form resembling the letter Y, indicating the space occupied by the head, is composed of a single article. The legs, of which the forms are analogous, though the dimensions differ considerably, are composed of seven joints, of which the first two form the haunch, the third the thigh, the fourth and fifth the leg, and the remaining two the tarsi; the last is terminated by a couple of hooks, which are usually toothed or pectinated, and in many species there is an additional tooth or smaller size, but not pectinated. The intestinal canal is straight: there is first a stomach composed of several sacks; and towards the middle of the abdomen a second dilatation occurs. According to Marcel de Serres the heart is situated in the abdomen, and stretches throughout its whole length; there is a considerable swelling towards its superior extremity, after which it assumes and retains the cylindrical form. It is very muscular, and its pulsations are strong and frequent. The pulmonary pouches, usually two in number, are always situated on the lower surface of the abdomen, near its origin, and are covered by a coriaceous skin, generally of a red colour; the stigmatiform opening proper to each pouch is placed towards its base, on the inner side. These pouches are formed of a white membrane, strong but flexible, which presents on its interior, transverse, projecting, parallel, nearly semicircular folds or plates, which constitute the respiratory organ. The liver is proper to the abdomen, of which it occupies the chief portion. It is composed of an infinity of minute glands fixed to the intestinal canal, and filled with a peculiar liquid, thick, and of a brown colour. The interior of the abdomen also contains the silk vessels, four in number, long, cylindrical, folded, yellow. They open into a common canal, situated at the origin of the spinners.

[1] According to M. Marcel de Serres (*Mémoire sur le Vaisseau Dorsal des Insectes*), the blood in the araneides and scorpions proceeds first to the respiratory organs, and from thence by special vessels to the various parts of the body. Latreille, however, seems to think, from the relations which exist between these creatures and the crustaceous tribes, that such circulation may be effected in the contrary direction. See the *Règne Animal*, tome iii. p. 212; and a memoir by Treviranus *On the Internal Organization of Arachnides*. 1 vol. 4to, Nuremberg, 1812.

[2] Some naturalists are of opinion that the two small spinners placed in the centre of the four exterior ones yield no silk.

The nervous system consists, 1*st*, of a cerebriform ganglion, placed towards the base of the thorax, quadrangular in some, in others rounded—from it proceed whitish nervous threads to the mouth, eyes, and feet; 2*dly*, of two nervous cords, derived from the above ganglion, which occupy the median line of the body, and of ganglia which distribute nervous filaments to the different organs, and principally to the alimentary canal and the silk vessels. M. Dufour did not ascertain the number and disposition of these latter ganglia. According to Treviranus they do not exceed two.

The dorsal and abdominal region of many spiders exhibit several small depressed points, which are produced by the attachment of the filiform muscles which traverse the liver. These are likewise observable in the scorpions.[1]

The silk vessels with which both sexes of many species fabricate those webs so remarkable at times for their symmetrical form and exquisite delicacy of structure, vary in shape and position according to the habits of the species. The formation by these creatures of skilfully wrought nets for the capture of their prey, is a fact of such every-day occurrence and observation, that we cease to regard it in its proper light, as one of the most admirable and surprising instincts of animal life. According to Reaumur, the silk undergoes its first elaboration in two small reservoirs, shaped like a drop of glass placed obliquely, one on each side, at the base of six other reservoirs in the form of intestines, which lie side by side, and folded six or seven times. The latter derive their origin from a little below the commencement of the abdomen, and proceed to the nipples by a slender thread. It is in the last-named vessels that the silk acquires that greater consistence and those other qualities which render it fit for use. A certain degree of dryness or evaporation seems necessary for the proper formation of the threads; but when the atmosphere is in a favourable condition the requisite change appears to take place almost instantaneously.

Various opinions have been entertained regarding the origin of those white, flaky, filamentous, silky substances which are frequently found floating in the atmosphere during the mornings of spring and autumn. They are called *fils de la vierge* by the French, and Lamarck still maintains the opinion that they are meteoric productions. The results of chemical analysis, as well as of ordinary observation, render it little less than certain that they are produced by small spiders of the genera *Epeira* and *Thomisus*. The innumerable threads which the sun-beams occasionally bring to view over the entire surface of ploughed fields are also formed by spiders of the genus Lycosa. Latreille is of opinion that many of these creatures, before they are sufficiently provided with spinning materials to form webs, content themselves by ejecting simple longitudinal threads. They are merely apprentices to the weaving art.

The habits of spiders vary greatly. Some rest in the centre of their webs, the outstretched cordage of which warns them of the temporary entanglement of their prey, on which they instantly rush, and devour after the infliction of a mortal wound. Others seek the protection of a leaf or other natural harbour, and only appear in the more open parts of their premises when lured by an expected capture. Many spin comfortable tunnels, or horizontal watchtowers, as they may be called, in which they repose till the vibration of their nets calls them into active service. An extensive tribe of erratic species (the *vagabundæ*) spin no webs at all, but trust to strength, activity, and cunning, for their daily, or, it may be, monthly fare; for spiders, though voracious in times of abundance, are capable of frequent and long-continued abstinence. The webless species are often endowed with the faculty of leaping, and after insidiously approaching their prey by the most wary and almost imperceptible footsteps, they spring upon it at once, and inflict the fatal wound. Several kinds hunt down their insect food by speed of foot; and a few are nocturnal, and surprise their defenceless and unsuspecting victims during the darkness of the night. According to Mr Sheppard, a large species, which occurs among the fen ditches of Norfolk, actually constructs a sort of raft of weeds, or floating island, on which it allows itself to be wafted about, and from which it seizes upon drowning insects; and another (*Lycosa piratica* of Walckenaer) gives chase to its prey over the surface of the water.

Unwet they bathe their oily forms, and dwell
With feet repulsive on the dimpling well.

The passion of love, so powerful in its influence over the most savage beasts, rules with a feeble and transitory sway over the subjects of our present inquiry. The male spider approaches the female with the greatest circumspection, fearful lest the sexual feeling should not have banished that thirst for blood which under ordinary circumstances induces them to prey as readily on each other as on winged insects. It therefore not unfrequently happens, that if a small male approaches a large female, whose feelings unfortunately do not coincide with his own, instead of being caressed he is eaten. According to Audebert, the female of the domestic spider is capable of producing successive generations without any renewal of intercourse with the male. He also states that he kept the same individuals in life for five or six years.

All female spiders, including even the erratic and webless species, are provided with reservoirs of silky matter, which, if not used in spinning, are at all events employed in forming a protecting covering for the eggs. The most casual observer of nature must have frequently remarked the care with which the anxious mother carries about and watches over her unhatched offspring; and the delicate colour of the silken bag which contains the eggs, and the fine contrast which in some cases it presents to the body of the parent, cannot have escaped observation. The truth is, that spiders, though frequently of a repulsive aspect, are as often distinguished not only by great beauty of colour, but by extreme elegance of form and delicacy of structure. We are prejudiced against the race in general, because all those that dwell within doors are of a dark and lurid hue, and from their haunts and habits have become objects of aversion and disgust. Thomson has well described,

[1] "L'organe reproducteur du male est formé de deux verges qui s'ouvrent à l'extrémité des palpes, et communiquent chacune avec un testicule en forme de poire, qu'on observe dans le thorax. On voit souvent à coté des verges deux crochets, servant au male à saisir la femelle. L'organe reproducteur de ces derniers individus est placé dans l'abdomen. Il est composé de deux valves, situées vers le milieu de sa partie inférieure, et près de son origine; à leurs deux ouvertures correspondent les oviductus, dont les membranes, en se développant, forment les ovaires. Ces organes ne sont point composés de canaux cylindriques, et ne consistent qu'en une membrane générale, enveloppant tous les œufs, et se divisant seulement vers sa base en deux parties qui se prolongent et constituent les oviductus. On decouvre vers la base des valves un organe particulier, analogue à l'oviscapre des femelles des insectes, coriace, ayant la figure d'un cuilleron, plus large vers son origine qu'à l'extrémité, ou il est assez allongé, et jouissant d'une certaine mobilité. Il parait fournir la matière soyeuse qui recouvre les œufs ou leurs cocons." (*Dict. Class. d'Hist. Nat.* tome i. p. 509.)

Where gloomily retired,
The villain spider lives, cunning and fierce,
Mixture abhorred! amid a mangled heap
Of carcases, in eager watch he sits,
O'er-looking all his waving snares around.
Near the dire cell the dreadless wanderer oft
Passes,—as oft the ruffian shows his front;
The prey at length ensnared, he dreadful darts
With rapid glide along the leaning line;
And fixing in the wretch his cruel fangs,
Strikes backward grimly pleased; the flutt'ring wing,
And shriller sound, declare extreme distress,
And ask the helping hospitable hand.

But many of those which live in fields, woods, and gardens, are worthy of being admired for their beauty, no less than for their singular instincts and remarkable modes of life.

The external appearance varies considerably in the same species, according to the age of the individual. The younger they are, the less varied is their colouring. The number and colour of the eggs differ according to the species. There is seldom more than a single laying of eggs in each year. In some species the eggs are free or unattached in the cocoons which contain them, in others they are fixed by agglutination. In the course of the summer season they are usually hatched in from fifteen to thirty days, according to the temperature. The eggs of such as deposit in autumn (as *Epeira diadema*, a fine species, which occurs in gardens, near the outskirts of woods, and in moors and furzes) are, however, seldom hatched till the commencement of the ensuing spring.

Some species of spider appear to possess the power of reproducing lost or mutilated parts, after the manner of the Crustacea. It is somewhere remarked, that in proportion to the simplicity of organic structure in an animal, its body is more capable of repairing by reproduction such portions as have been destroyed or deteriorated. This would induce the belief that frogs and lizards are lower in the scale than insects, and that the latter, which do not possess the reproductive power, are more highly organized than spiders and other Arachnides. This, however, is not the case; and we may therefore infer that the principle itself is erroneous, or at least incapable of general application. The ascertainment of the fact, that spiders were capable of effecting this repair of parts, is due to the ingenious observations of MM. Vincent Amoreux and Amédée Lepelletier. It was also, however, observed by Sir Joseph Banks in this country, and communicated by him to Dr Leach, by whom the circumstance was recorded in the Supplement to the sixth or preceding edition of this work.

As Sir Joseph was writing one evening in his study, a web-spinning spider, above the medium size, passed over some papers on the table, holding a fly in its mouth. Surprised to see a spider of this description walking about with its prey, and struck with something peculiar in its gait, he caught and placed it under a glass for examination, when he perceived, that instead of eight legs, it had only three. This mutilation accounted sufficiently for its inability to spin a web; but the singular circumstance of its having changed its natural habits, and having become a hunting instead of a spinning spider, and his desire to ascertain whether its limbs would be reproduced, induced Sir Joseph to prolong its captivity. On the following morning the creature destroyed two flies by sucking out their juices, leaving the bodies entire. Two or three days afterwards it devoured the body and head of a fly, leaving only the wings and legs. After this time it sometimes sucked and sometimes swallowed the flies.

Soon after its confinement it attempted to form a web on the side of the vessel, but performed the operation very slowly and awkwardly, owing to the want of the proper number of legs. However, in the course of about a fortnight it had completed a small web, upon which it generally sat, and no doubt regarded with complacency. A month after being caught it shed its skin, leaving the slough on the web. After this change five new legs began to appear, which for a short period were of little or no use to it in walking. These new members, however, extended themselves considerably in the course of three days, and became about half as long as the old ones. The web was now increased, and the spider continued immovably sitting on it in the day-time, unless drawn from it, or attracted by a fly thrown to it as its usual provision. Twenty-nine days afterwards it again cast its skin, leaving the slough hanging in the web, opposite to a hollow cell it had woven so as to prevent itself from being completely seen. The legs were now larger than before the change of the skin, and they continued to increase for several days, but did not attain the size of the old legs. It was then put into a small bowl as a more commodious and convenient residence, where it spun a larger and more perfect web. We are not acquainted with the result of any further observations on the subject.

Various attempts have been made at different periods to fabricate gloves and stockings from the silk of the spider. Nearly a century ago, Bon of Languedoc succeeded in making a pair of each of these articles from this frail material: they were nearly as strong as those of common silk, and of a fine gray colour. Reaumur was appointed by the Royal Academy to report on the advantages which might result from the regular prosecution of a manufactory from spider-silk; but his opinion was, that the natural fierceness and voracity of spiders rendered them entirely unfit to be bred and brought up together. From 4000 to 5000 were distributed in cells, each containing from 50 to 200 individuals; but in a short time only a few were left alive. He also stated, that the web of the spider was not equal to that of the silk-worm, either in strength or lustre. The cocoons of the latter weigh from three to four grains, so that 2304 worms produce a pound of silk. But the bags of a spider, when cleaned of filth and dust, do not weigh above the third part of a grain, so that the work of twelve spiders does not exceed that of a single silk-worm, and to form a pound of silk 27,648 spiders would be required; and as it is the females alone that spin the bags, if they are kept in pairs for the purpose of breeding, 55,296 individuals would be necessary to the formation of every pound. Even this calculation applies only to good spiders of the domestic breed, for those found in gardens scarcely yield the twelfth part of silk of the house species; therefore 280 would not produce more than a single silk-worm, and 663,555 would scarcely yield a pound of silk.[1]

Sir George Staunton, in his *Embassy to China*, states that spiders' webs are met with in the forests of Java of so strong a texture as to require to be cut through with a knife; and in the *Philosophical Transactions* (1668) we are informed that the spiders of Bermudas suspend their webs between trees seven or eight fathoms distant, and that they are so strong as to entangle birds as large as thrushes. "The web of a house-spider," observe Messrs Kirby and Spence, "will, with occasional repairs, serve for a considerable period; but the nets of the geometric spiders are in favourable weather renewed, either wholly, or at least their concentric circles, every twenty-four hours,

[1] *Memoirs of the Academy*, 1710.

even when not apparently injured. This difference in the operations of the two species depends upon a very remarkable peculiarity in the conformation of their snares. The threads of the house-spider's web are all of the same kind of silk, and flies are caught in them from their claws becoming entangled in the fine meshes which form the texture. On the other hand, the net of the garden spider is composed of two distinct kinds of silk; that of the radii not adhesive, that of the circles extremely viscid. The cause of this difference, which, when it is considered that both sorts of silk proceed from the same instrument, is truly wonderful, may be readily perceived. If you examine a newly formed net with a microscope, you will find that the threads composing the outline and the radii are simple, those of the circles closely studded with minute dew-like globules, which from the elasticity of the thread are easily separable from each other. That these are in fact globules of viscid gum, is proved by their adhering to the finger, and retaining dust thrown upon the net, while the unadhesive radii and exterior threads remain unsoiled. It is these gummed threads alone which retain the insects that fly into the net; and as they lose their viscid properties by the action of the air, it is necessary that they should be frequently renewed."[1]

Dr Lister was of opinion that spiders possessed the power of again withdrawing their webs within their bodies,—a fact which, with Degeer, we may reasonably doubt, when we consider the immediate atmospheric change which takes place in the nature of the thread after it is once protruded. In fact, when a spider ascends on the same cord by which it had previously dropped from a height, a small ball or rounded web will be found adhering to it, composed of the coil which it has collected in its re-ascent. The extreme tenuity of the component or elementary threads of the spider's web has been well explained by Leeuwenhoeck. He states that the threads of the minutest spiders, some of which are not equal in bulk to a grain of sand, are so fine that four millions of them would not exceed the thickness of a human hair. Now we know that each spinner, of which there are four, is pierced by about a thousand holes, consequently that every compound or ordinary thread is composed of 4000 still finer. Thus a spider's thread, of the thickness of a human hair, may in some instances be composed of not fewer than *sixteen thousand millions* of single threads!

The bite of an ordinary spider occasions almost instant death to most insects. The great species of South America attack vertebrated animals, such as humming-birds and young pigeons, and their bite is often attended with dangerous consequences even to the human race. Spiders are themselves preyed upon by birds; and a winged insect of the genus *Sphex* pierces them with its sting, carries them off, and buries them dead or alive in holes where its eggs are deposited, the larvæ produced from which afterwards feed upon the dead body of the spider. Most species perish about the commencement of winter, although many others are known to exist for several years. According to Sparmann, they form an article of food to the Bosjiesmen of Southern Africa; and Labillardiere relates, that the inhabitants of New Caledonia eat with avidity great quantities of a spider nearly an inch long (*A. edulis*), which they roast over the fire.[2]

The ascent of spiders into the air, and the extension of their webs from tree to tree across an open space, or even over a running stream, have frequently excited the attention of naturalists. Dr Lister relates, that attending minutely to a spider at work weaving its net, he observed it suddenly desist, and, turning its nipples to the wind, dart out a thread with the violence of a water jet. This thread, taken up by the wind, was carried to some fathoms' length, still issuing from the body of the animal. Some time after the spider leapt into the air, and the thread mounted her up swiftly. He afterwards made the same observation on about 30 other species of spiders, and found the air filled with young and old sailing on their threads, and probably seizing insects in their passage, as he found legs and wings, and other manifest signs of slaughter, on these threads, as well as on the webs below. These observations were corroborated by Dr Hulse, who made the like discovery about the same time. It is Dr Lister's opinion that this darting of threads was known to Aristotle and Pliny (vide *Hist. Anim.* lib. ix. cap. 89; and *Plin.* lib. x. cap. 74), but he believes their sailing was first observed by himself. On these sailing spiders he further observes, that they will often dart, not a single thread alone, but a whole sheaf at once, consisting of many filaments, all of one length, but divided from each other, and distinct; and the longer they become, the more they spread, and appear like the numerous rays of a blazing star. He observed, too, that some species seemed to use their legs as oars, sometimes closing, and again spreading them out, as occasion might require. When the air is still it is highly probable they can direct their course, and perhaps mount or descend at pleasure. In rowing, he observed they always take their flight backwards. These threads mount to an almost incredible height, and may always be observed in a fine clear day in autumn, when there is little or no wind. In a letter to Mr Ray, he further states, that "I one day observing the air full of webs, forthwith mounted to the top of the highest steeple on the minster (at York), and could there discern them exceedingly high above me."

If a spider is placed on the top of a pole surrounded by water, it nevertheless effects its escape by means of a silken line, which is ere long found to extend from the pole to some other object on the outside of the pool. It is evident that the spider possesses the power of permitting the material of which its threads are composed to escape at pleasure; but whether this is accomplished by a projectile force, by electrical agency, or by the mechanical action of the external currents of the atmosphere, is still a subject of dispute. The beautiful regularity with which the radiated parts of the web are usually disposed favours the idea expressed by a French writer, that the animal possesses the power of shooting out its threads and directing them at pleasure towards a determined point; whilst the observations of Messrs Rennie and Blackwall indicate the necessity of a current of air as a moving force. It appears, from the experiments of the latter gentleman, that when spiders are placed upon an insulated twig surrounded by water, and exposed to a current of air, however slight, either naturally or artificially produced, they directly turn the thorax towards the quarter from whence it came, and elevating the abdomen, they emit from their spinners a small portion of glutinous matter, which is instantly carried out in a line, consisting of four finer ones, with a velocity equal or nearly so to that of the air. They next carefully ascertain whether their lines have become firmly attached to any object, by pulling at them with their anterior pair of legs; if the result satisfies them, they glue the nearer end to the twig, and then march across. "Such was invariably the result when spiders were placed where

[1] *Introduction to Entomology*, vol. i. p. 414.
[2] *Voyage à la Recherche de la Perouse; Introduction to Entomology*, vol. i. p. 302.

the air was liable to be sensibly agitated: I resolved therefore to put a bell glass over them, and in this situation they remained 17 days, evidently unable to produce a single line by which they could quit the branch they occupied, without encountering the water at its base; though, on the removal of the glass, they regained their liberty with as much celerity as in the instances already recorded." (*Linn. Trans.* vol. xv.) Mr Blackwall affirms with confidence, that in motionless air, spiders have not the power of darting their threads even through the space of half an inch. Mr Murray, Mr Bowman, Mr Mark Watt, and others, maintain a contrary opinion.

Lastly, Mr Virey thinks it more probable that spiders actually fly (by vibrating their feet) through the air, than that they are acted upon either by electrical influences or the agitation of the air. He does not assert that they have wings.

The bodies of spiders decompose so rapidly after death, that both their forms and colours are speedily altered and effaced. It is therefore with great difficulty that they are preserved as subjects of examination in museums. Hence, perhaps, our comparative ignorance both of their structure and habits.

Sect. I.—Tetrapneumones.

Two spiracles and two pulmonary sacks or pneumobranchia on each side.

This section is characterized by the position of the eyes, which are always placed at the anterior extremity of the thorax, and usually close to each other. The mandibles (*chelicères* of Latreille) and feet are robustly formed. The greater proportion of species have only four spinners. They fabricate silken tubes, in which they dwell, and these are placed sometimes in subterranean tunnels, sometimes under stones, and sometimes beneath the bark or among the leaves of trees.

The first division of the section corresponds to the *Theraphoses* of Walckenaer, and contains the three following genera, viz. Mygale, Atypus, and Erodion. These are distinguished from the others by having four spinners and eight eyes, and by the hooks of their mandibles being bent underneath instead of inwards.

Genus Mygale, Walckenaer.—Palpi inserted at the superior extremity of the maxillæ, in such a manner that they appear to be composed of six articles, of which the first, straight and elongated, with the inner angle of its upper portion projecting, performs the function of a jaw. The languette is small and nearly square. The last joint of the palpi in the male is button-shaped, and bears at its extremity the reproductive organs; and the two anterior legs in that sex are provided with two strong spines or spurs at their inferior extremity.

This genus, as established by Walckenaer, is composed of the bird-catching spiders (*A. avicularia*, Linn.), and the *Araignées mineuses* of Olivier. It contains several species of great size and singular habits. The foreign kinds are as yet imperfectly characterized. The habits of a large species found in Martinique, where it is called *Matoutou*, have been well described by Moreau de Jonnés. It spins no web, but lies concealed in holes and crevices of the volcanic tufa, from which, however, it makes frequent excursions in search of prey, which consists not only of insects, but of humming-birds and other species of the feathered race. It hunts chiefly during the night. It is possessed of great muscular strength, and unwillingly quits an object of which it may have become possessed. When induced to seize upon any hard and polished substance, it leaves traces of a poisonous liquid, which, had the substance been of a yielding nature, it would have injected into the wound. This liquid is lactescent, or of a milky aspect, and very abundant in proportion to the size of the animal. The female carries her eggs in a cocoon of white silk, of a very close texture, which she holds by means of her palpi, beneath the thorax. When attacked, she drops her eggs to defend herself, and secures them again when the combat has ceased. The young, when first produced, are entirely white; and the earliest change which they experience is the appearance of a black spot in the centre of the dorsal surface of the abdomen. From eighteen hundred to two thousand young have been observed to proceed from a single silk bag; but of these it is probable that an immense proportion perish in infancy, by the depredations both of birds and insects.

Several species of this genus inhabit Europe, and their characters and economy are detailed by Olivier, Latreille, the Abbé Sauvage, and other writers. Our restricted limits prevent our describing more than a few, which we shall select as well from the indigenous as exotic.

† Superior extremity of the mandibles unprovided with a series of transverse spines or corneous points. Tarsi furnished with a thick hairy brush, which conceals the crotchets.

Sp. Avicularia.—*Aranea Avicularia*, Linn. The bird-catching spider, Shaw. (Pl. XLVI. fig. 1)—Body nearly two inches long, very hairy, especially in the young. Thorax depressed, large, oval, truncated posteriorly. General colour black; the extremities of the palpi, the feet, and inferior hairs of the mouth, reddish. Hooks of the mandibles strong, conical, and very black. This species is said to dwell in the clefts of trees, and in hollows among rocks and stones. According to Madame Merian, it surprises small birds on their nests, and sucks their blood with avidity. It forms a tube-shaped cell, narrow at its posterior extremity, composed of a fine white semi-transparent tissue, resembling muslin. The cocoon of this species is like a large walnut in size and form. Its native countries are Cayenne and Surinam. Other nearly allied species also occur in those parts of South America, as well as in Africa and the East Indies. Their bite is dangerous, although the accounts given by Piso and other authors is no doubt exaggerated. To this section may be referred the *M. blondi* (Pl. XLVI. fig. 2), *cancerides*, *fasciata*, *atra*, and *brunnea* of Latreille.

†† Superior extremity of the first piece of the mandibles provided with corneous points like the teeth of a rake. The tarsi are not so covered with hair as to conceal the crotchets.

The species of this section inhabit dry and mountainous places, where they form tunnels or subterranean galleries, sometimes two feet in depth. At the entrance they construct a door, moving upon a hinge, and formed of silk and clay, undistinguishable from the surrounding soil. There is what we may not improperly call a mat of silk fastened to the inner surface of the door, on which the animal frequently reposes, probably for the sake of guarding the entrance, and being at hand to secure its passing prey. A fine silk tube, which is the proper dwelling, clothes the interior of the gallery. M. Dufour is of opinion that the females alone excavate the tunnels.

Sp. Cæmentaria.—*Araignée mineuse*, Dorthes. In *Linn. Trans.* ii. (Pl. XLVI. fig. 3.)—The female of this species is about eight lines in length, of a reddish-brown colour, somewhat pale on the edges of the thorax. The mandibles are blackish, and are each furnished near the articulation of the crotchet with five points, of which the innermost is the shortest. The abdomen is mouse-coloured, with darker spots. The first article of all the tarsi is

furnished with small spines, the crotchets of the last have a spire at their base, and a double range of pointed teeth. The spinners are but slightly projecting. The *M. carminans* of M. Latreille (2d edit. of the *Nouv. Dict. d'Hist. Nat.*) is supposed to be the male of this species. He differs in the greater length of his legs; in the crotchets of the tarsi, of which the teeth are more numerous; in the want of the spines, and the greater shortness of the spinners. His two anterior feet are terminated beneath by a strong spine.

This species inhabits Spain, the southern parts of France, and other shores of the Mediterranean. Its habits are presumed to be nocturnal, as it is never seen abroad or at work during the day.[1] It forms its tunnel in strong earth, free from stones, and on a sloping surface to avoid moisture. It resists the opening of its door with its utmost strength, and continues struggling in the entrance till the light has fairly entered, after which it retreats into the earth. The door is beautifully formed, and suspended on a hinge from above, so that it always shuts close of its own accord. It preys upon beetles and other large and strong insects. When its door is cut off or unhinged, it forms another in its place, which, according to Rossi, differs from the first in not being movable. The Italian author does not mention by what means its entrance and exit are then accomplished; but Latreille has suggested that the experiment may have been tried just before the commencemen of winter, and that the second operculum was closed with a view to exclude the rigours of that inclement season.

In the following genera of this division the palpi are inserted upon an inferior dilatation of the external side of the maxillæ, and consist of only five articles. The languette, at first very small, as in the genus Atypus, afterwards becomes elongated and advanced between the jaws. The last joint of the palpi in both sexes is lengthened and antennated towards the extremity. The males are not provided with a strong spur at the extremity of the two anterior legs.

Genus Atypus, Latreille. Oletera, Walckenaer.—Languette very small, and almost covered by the external portion of the base of the maxillæ. Eyes contiguous, and grouped upon a tubercle.

Sp. Sulzeri, Latreille. *Aranea Picea*, Sulzer. (Pl. XLVI. fig. 4.)—General colour blackish. Length of the body eight lines. Thorax nearly square, depressed posteriorly, enlarged and broadly truncated in front. The mandibles are strong, and their claw is furnished near the base with a tooth-like projection. The last article of the palpi in the male is pointed at the extremity.

This is the only species of the genus known in Europe. It was first described by Sulzer as a Swiss species (*Geschichte der Insecten*. Pl. XLVI. fig. 2). It has since been observed by several French entomologists at Sevres, near Paris, and was discovered in this country by Dr Leach, near Exeter. Its habits are curious and interesting. It constructs for its dwelling a silky scabbard, intermingled with moss, eight or ten inches long. Its direction is at first horizontal over the surface of the ground, and then perpendicular beneath the surface. The eggs are deposited at the bottom, enveloped in a white web. The animal itself is slow in its movements. It is most frequently met with in the month of July. It appears to have been described and figured by Roemer as the *subterranean spider*.

An American species, the *Atypus rufipes* of M. Milbert, of which the body is entirely black, and the feet rufous, occurs in the neighbourhood of Philadelphia.

Genus Erodion, Latreille. Missulena, Walckenaer.—This genus differs from the preceding in its straight, elongated languette, which projects between the jaws. Its eyes are spread over the front of the thorax.

Sp. Occatorius, Latreille, Walckenaer. Body black, about an inch in length. Brought from New Holland by M. Lesueur.

The second division of this section exhibits the prolonged languette of the Erodions, and the palpi composed of five articulations; but the claws of the mandibles are folded inwards instead of downwards. The spinners are six in number; and the first pair of legs, instead of the fourth, are the longest. Some of these Arachnides have only six eyes.

Genus Dysdera, Latr. Walck.—Eyes six, disposed in the form of a horse-shoe, opening outwards. Mandibles strong and projecting. Maxillæ straight, and dilated towards the insertion of the palpi.

Sp. Erythrina (Pl. XLVI. fig 5.)—Mandibles and thorax sanguineous; colour of the legs lighter. Abdomen soft and silky, and of a grayish yellow.

Inhabits the south of France and England, beneath stones. It is rare in the latter country, but has been taken near Plymouth, Exeter, and London. A variety of this species has been described by Scopoli under the name of *Aranea hombergii*.

Genus Filastata, Latr.—Eyes eight, placed on a small elevation at the anterior extremity of the thorax. Mandibles small; maxillæ arched on their exterior side.

Of this genus the *F. testacea* of Walckenaer was discovered near Marseilles. The *F. bicolor* is described in the *Faun. Franc. Arach.* vi. 1–3.

Sect. II.—Dipneumones.

A. Sedentariæ.

The genera of this great division are possessed of only a pair of pulmonary sacks, and corresponding stigmata. The palpi, composed of five joints, are inserted on the exterior side of the maxillæ, near their base, generally in a sinus. The languette is advanced between the maxillæ, and is sometimes nearly square, sometimes triangular or semicircular. The spinners are six in number. The last article of the palpi in the males is more or less ovoid, and usually contains the generative organs in an excavation.

The first four tribes of this section may be considered as forming a large group, which we name *Sedentariæ*. They either spin webs for the capture of their prey, or throw out isolated and irregular threads for the same purpose. Their eyes are grouped across the front of the thorax. Of these there are usually eight; four or two in the centre, and two or three on each side. Sometimes there are only six eyes.

The first three of these tribes, viz. *Tubitelæ, Inæquitelæ*, and *Orbitelæ*, are sometimes included under the more general appellation of Rectigrade, from their straightforward mode of progression, particularly as contrasted with that of the fourth tribe or *Laterigradæ*, which, like many of the crustaceous class, can direct their steps in different directions without turning the body. In these tribes the relative length of the legs is variable. In many the first and the last pair are the longest; in others the two

[1] The eyes of spiders are occasionally observed to shine in the dark like those of cats, moths, &c., and they probably enjoy the faculty of seeing both by night and day.

Arachnides.

anterior pairs; while in some the third and fourth pair are the most extended. The eyes, in their general disposition, do not form a crescent, or the segment of a circle.

TRIBE I.—TUBITELÆ.

Spinners cylindrical, close to each other, directed backwards. The feet are robust; the first and last pair are the longest.

GENUS CLOTHO, Walckenaer. UROCTEA, Dufour.—Mandibles very small, capable of little extension, and without teeth. Crotchets small, body short, legs long, the third and fourth pair rather longer than the preceding. The eyes are disposed as in genus Mygale. The maxillæ have on their external side a slight dilatation at the insertion of the palpi, and terminate in a point. The languette is triangular. The superior or lateral spinners are the longest; but the most peculiar character, according to M. Dufour, is the existence, in the position of the intermediate spinners, of a pair of comb-shaped valves, which open or close at the will of the animal.

Sp. 5-maculata.—Body about an inch in length, of a chesnut-brown colour; the abdomen black, with five small round yellowish spots, of which four are disposed transversely in pairs, and the fifth is single and posterior.

This species was found in Egypt by M. Savigny. It occurs in Dalmatia, and near Montpellier; also in Catalonia, and other parts of Spain. Its manners have been described by M. Dufour.

GENUS DRASSUS, Walck.—Mandibles robust, projecting, toothed beneath. Maxillæ obliquely truncated at their extremity. The eyes are nearer the anterior edge of the thorax, and the line formed by the four posterior exceeds in length that formed by those on the anterior line. The fourth and second pair of feet are obviously longer than the others. The legs and first joints of the tarsi are armed with sharp points.

The spiders of this genus live under stones, in the clefts of walls, and among leaves. They form little dwelling-places of white silk. The cocoons of some are orbicular, flattened, and composed of two valves applied one against another.

Sp. Relucens.—Small, cylindrical, with a yellow thorax, covered with a purple silky down. The abdomen is thin, red, and green, with metallic reflections, and two transverse lines of golden yellow, of which the anterior is arched. One variety has also four additional golden spots. The species is generally found running on the ground. It is common in the environs of Paris, and is one of the most beautiful of the tribe.

GENUS SEGESTRIA, Latr.—Eyes six, of which four are anterior on a transverse line, and two posterior, placed on each side behind the two lateral eyes of the preceding line. The languette is elongated and almost square. The first and second pair of feet are the longest, and the third pair the shortest.

The species of this genus spin cylindrical elongated webs in the clefts of old walls, in which they lie concealed, with their anterior pair of legs stretched forwards. Divergent threads of glutinous silk border the external opening to their habitation, and form a net for the capture of their insect prey.

Sp. Senoculata.—Thorax blackish-brown. Abdomen oblong, grayish, with a longitudinal band of blackish spots. Legs pale brown, obscurely banded. Inhabits rocks and old buildings.

GENUS ARANEA, Latr. TEGENERIA, Walck.—The two upper spinners conspicuously longer than the others. The four anterior eyes placed in a curved line, bending backwards. The first and last pair of legs the longest.

This genus inhabit the interior of our dwellings; also the angles of old walls, on plants, hedges, &c. They construct large webs, nearly horizontal, at the higher part of which is a tube or tunnel, where the spider lies concealed.

Sp. Domestica.—Of a livid ash colour. Thorax of the male without spots. On that of the female there is on each side a blackish band. Abdomen blackish, with a longitudinal spotted band on the back.

This is the most frequent inhabitant of our houses, and an object of more than common aversion. It sometimes attains to a large size. According to Homberg, it is subject, especially in the kingdom of Naples, to a disease which renders it more than usually hideous. Its body becomes covered with scales, among which a number of mites engender. Geoffroy was of opinion that a spider was supplied only with a certain portion of spinning material; that if the web was intentionally destroyed, and an individual frequently obliged to reconstruct its web, it became at last incapable of further exertion in that line, and would probably perish for want of the usual means of subsistence.

The spiders of this country are entirely harmless, from their want of power to pierce the skin. But that they are furnished with a poisonous liquid, which they instil into the wound of their victims, cannot be doubted. Olivier, indeed, reports, that a farmer in one of the Isles d'Hières was bitten by a large spider while turning a sheaf of wheat. The wound occasioned at first only a slight inflammation, so trivial that it was for some time neglected, till its increase created alarm. Gangrene and death ensued. They may be taken internally with impunity. " J'ai vue," says Latreille, " le célèbre astronome Lalande avaler de suite quatre gros individus de cette espèce." (*A. domestique.*)

GENUS ARGYRONETA, Latr.—Maxillæ inclined upon the languette, of which the form is triangular. The four central eyes form a quadrangle; the lateral pair of each extremity are grouped together, and placed on a small eminence.

Sp. Aquatica. Aranea Aquatica, Lin. Geoff.—Of a blackish-brown colour, the abdomen deeper, surface silky, the back with four impressed points. Lives in ditches and slow-running waters, beneath the surface of which it spins a beautifully constructed web. " The habitation of *aranea aquatica*, the other spider to which I alluded, is chiefly remarkable for the element in which it is constructed, and the materials that compose it. It is built in the midst of water, and formed in fact of air! Spiders are usually terrestrial; but this is aquatic, or rather amphibious: for though she resides in the midst of water, in which she swims with great celerity, sometimes on her belly, but more frequently on her back, and is an admirable diver, she not unfrequently hunts on shore, and having caught her prey, plunges with it to the bottom of the water. Here it is she forms her singular and unique abode. She would evidently have but a very uncomfortable time were she constantly wet; but this she is sagacious enough to avoid, and, by availing herself of some well-known philosophical principles, she constructs for herself an apartment, in which, like the mermaids and sea-nymphs of fable, she resides in comfort and security. The following is the process:—First she spins loose threads in various directions, attached to the leaves of aquatic plants, which may be called the frame-work of her chamber; and over them she spreads a transparent varnish resembling liquid glass, which issues from the

middle of her spinners, and which is so elastic that it is capable of great expansion and contraction; and if a hole be made in it, it immediately closes again. Next she spreads over her belly a pellicle of the same material, and ascends to the surface. The precise mode in which she transfers a bubble of air beneath this pellicle is not accurately known; but from an observation made by the ingenious author of the little work from which this account is abstracted, he concludes that she draws the air into her body by the anus, which she presents to the surface of the pool, and then pumps it out from an opening at the base of the belly, between the pellicle and that part of the body, the hairs of which keep it extended. Clothed with this aerial mantle, which to the spectator seems formed of resplendent quicksilver, she plunges to the bottom, and, with as much dexterity as a chemist transfers gas with a gasholder, introduces her bubble of air beneath the roof prepared for its reception. This manœuvre she repeats ten or twelve times, until at length, in about a quarter of an hour, she has transported as much air as suffices to expand her apartment to its intended extent, and now finds herself in possession of a little aerial edifice—I had almost said an enchanted palace—affording her a commodious and dry retreat in the very midst of the water. Here she reposes unmoved by the storms that agitate the surface of the pool, and devours her prey at ease and in safety. Both sexes form these lodgings. At a particular season of the year the male quits his apartment, approaches that of the female, enters it, and enlarging it by the bubble of air that he carries with him, it becomes a common abode for the happy pair.[1] The spider which forms these singular habitations is one of the largest European species, and in some countries not uncommon in stagnant pools."[2]

Tribe II.—Inæquitelæ.

External spinners conical, convergent, slightly projecting, disposed *en rosette*. Legs slender, first and last pair usually the longest. The maxillæ are inclined on the tongue, and are either narrow or present no sensible enlargement at their superior extremity. The abdomen is more voluminous, softer, and more highly coloured than in the preceding tribe. Their webs constitute an irregular net-work of various forms, the threads of which cross each other in different directions. They bind their prey with cords, which, though silken, secure them very effectually. The species are short-lived, and tend their eggs very carefully till the exclusion of the young.

Genus Scytodes, Latr.—Eyes six, disposed in pairs. M. Dufour states that the crotchets of the tarsi are inserted in a supplementary article.

Sp. Thoracica. (Pl. XLVI. fig. 6.)—Pale reddish-white, spotted with black. Thorax large, somewhat orbicular. Abdomen not globose.

This species inhabits houses. It has been found near Dover, but is otherwise scarcely known as a British species.

Genus Theridion, Walck.—Eyes eight in number, of which four in the centre form a square, the two anterior being placed upon a small eminence, and a pair are placed on each side upon a common elevation. The thorax is almost triangular, or shaped like a heart reversed.

Sp. Malmignatto. *Aranea 13-guttata*, Fab.—Lateral eyes, separated from each other. Body black, with thirteen small round spots of a blood-red colour on the abdomen. This species inhabits Corsica, the inhabitants of which island hold it in great dread, from the belief that its bite is dangerous, if not mortal.

Another species, the *Theridion benignum* of Walckenaer, may from its name be presumed to possess another character. It lives in autumn among the clusters of grapes, where it watches for its prey, and thus deters many insects from injuring the fruit. The prejudice against this genus probably arises from several of them being of a dark colour, with red spots resembling drops of blood upon their bodies.

Genus Episinus, Walck.—Eyes eight, near each other, and placed upon a common elevation. The thorax narrow and almost cylindrical.

Sp. Truncatus.—Thorax acute in front, rather longer than broad, obscure brown above, reddish brown beneath. Abdomen pyramidal, truncated behind, its anterior portion brown, third pair of legs whitish, the others brown.

Genus Pholcus, Walck.—Eyes eight, tuberculated, divided into three groups, of which there is one on each side composed of three eyes disposed in a triangle, and a third in the centre, somewhat advanced, composed of two eyes on a transverse line.

Sp. Phalangioides, Walck. *Araignée domestique à longues pattes*, Geoff.—Body long, narrow, pubescent, of a livid or pale yellow colour. The abdomen is almost cylindrical, very soft, and spotted above with black. The legs are very long and slender, with whitish rings at the extremities of the thighs and tibiæ.

This species is common in houses in the western parts of England. Its body vibrates like that of some tipulæ. The female carries her eggs in an agglutinated mass between her mandibles.

Tribe III.—Orbitelæ.

In this tribe the exterior spinners and the legs resemble those of the preceding, but the maxillæ differ, being straight, and sensibly broader at their extremity. The first and second pair of legs are the longest. The eyes are eight in number, of which four are placed quadrangularly in the centre, and a pair on each side. These spiders differ from the *Inæquitelæ* in the form of their webs, which are composed of a regular net-work, formed of concentric circles, crossed by straight lines or radii, proceeding from the centre, where the animal lies, to the circumference. Some conceal themselves in cavities, or in chambers built by themselves, near the margins of their webs, which are sometimes horizontal, sometimes perpendicular. Their eyes are numerous, agglutinated, and inclosed in a large cocoon.

Genus Linyphia, Latr.—Four central eyes, of which the posterior pair are larger, and separated by a larger space; the others are in pairs, one on each side, and placed obliquely. The maxillæ are enlarged at their superior extremity.

This genus constructs among brooms and other bushes a slender, open, horizontal net, from which various threads proceed irregularly upwards to different points.

[1] *Mémoire pour servir à commencer l'Histoire des Araignées Aquatiques.*
[2] *Introduction to Entomology*, by Kirby and Spence, vol. i. p. 469.

Sp. Triangularis.—Pale red, inclining to yellow. Thorax with a dark dorsal line, bifid in front. Abdomen oval, inclining to globose, with spots and angulated bands of brown and white. Inhabits the European hedges, and constructs its webs on brooms and pine-trees.

Genus Uloborus, Latr.—Four posterior eyes placed at equal distances on a straight line, and the two lateral eyes of the first line nearer the anterior margin of the thorax than the intermediate pair, so as to form an arch bent backwards. The maxillæ commence in this genus to enlarge a little above their base, and terminate in the form of a spatula. The tarsi of the last three pair of legs are terminated by a single claw. The first article of the two posterior pair have a range of small hairs.

These spiders repose in the centre of their webs, with their four anterior feet stretched forwards; the third pair are extended laterally, and the posterior pair backwards.

Sp. Walckenarius, Latr.—Of a reddish-yellow colour, covered by a silky down, forming on the upper part of the abdomen two series of small bundles. Length about five lines. The legs are marked with paler rings. Occurs near Bordeaux, and other southern departments of France.

Genus Tetragnatha, Latr.—Eyes placed four and four on two nearly parallel lines, and separated by almost equal intervals. Maxillæ long, narrow, enlarged only at their superior extremity. Mandibles also very long, especially in the males. Their web is vertical.

Sp. Extensa.—Abdomen oblong, golden green, with the sides and two lower lines yellowish. Sits with its legs extended on a vertical web. Inhabits moist places.

Genus Epeira, Walck.—A pair of eyes on each side, almost contiguous; the other four forming a central quadrangle. The maxillæ dilated from their base.

With the exception of that of *E. curcubitina*, which is horizontal, the webs of this genus are either vertical or inclined. Some repose in the centre of their webs, with their bodies reversed, or heads downwards; others construct a sheltering habitation, sometimes formed of leaves spun together, sometimes like a silken tube, or of a more open form like a bird's nest, in the vicinity of their nets. Some foreign species construct such powerful webs as to arrest the flight of small birds, and even to incommode the traveller while journeying through the forests. Many of the species are remarkable for the beauty of their colours, their singular forms, and still more singular habits. Between 60 and 70 species are described by M. Walckenaer in his *Tableau des Aranéides;* and M. Leon Dufour has greatly contributed to illustrate the history of this extensive genus in the *Annales des Sciences Physiques* of Brussels, and the *Annales des Sciences Naturelles* of Paris. We regret that the limits of our present undertaking do not admit of our entering into further details.

Sp. Diadema. (Pl. XLVI. fig. 7.)—Reddish; abdomen globose-oval, with an elevated angle on each side near the base; dorsal band darker, broad, triangular, dentated, with a triple cross of yellowish-white spots, and four impressed dots disposed in a quadrangle. Legs and palpi spotted with black.

This is one of the largest of the British species. It frequents the borders of woods, rocks, and gardens; also moors and other desert places. It varies considerably both in size and colour. We are indebted to Treviranus for an account of its anatomical structure. The heart presents a character not observed in that of any other species. From its inferior and anterior part proceed two muscles, which, at first united in one, diverge as they approach the posterior portion of the abdomen. The heart itself exhibits several branches, the two anterior of which are sent to the branchia; and the function of these last-named organs, according to Treviranus, is to absorb humidity from the atmosphere, and convey it to the circulating system. The true respiratory organs are discoverable in a species of stigmata placed in the thorax and abdomen. These stigmata are not pierced, like those of insects; but numerous vessels are seen distributed over their surface.

The sceptre or diadem spider, as this species is frequently called, pairs about the end of summer, and deposits its eggs in autumn. The eggs are of a fine yellow, inclosed in a cocoon of a close texture, but covered with a looser substance of a yellowish hue. This spider forms no nest, but shelters itself beneath a leaf or some other natural covering. Its web is large and vertical. The young are hatched in spring, and are at first yellow, with a blackish spot on the upper part of the abdomen.

M. Vautier has described a singular species of this genus, remarkable for the posterior enlargement of its abdomen, which is terminated by a couple of arched and elongated spines. (*Annales des Sciences Naturelles*, tome i. p. 261.) It is named *Epeira curvicauda.* (Pl. XLVI. fig 8.)

Tribe IV.—Laterigradæ.

The species which constitute this tribe are, like those of the preceding, of sedentary habits; but they differ in their mode of progression, being able to walk sideways and backwards, as well as straight forward like the others. Hence the designation of the tribe. Their four anterior feet are always longer than the others. In some the first pair are longer than the second; in others they are nearly equal. The mandibles are usually small, with their crotchets transversely folded, as in the preceding tribes. The eyes are always eight in number, frequently unequal, and forming by their union a crescent, or the segment of a circle. The maxillæ in the generality of this species are inclined upon the lip. The body is generally flattish, crab-shaped, with the abdomen large, rounded, and triangular.

The genera included in this division can scarcely be said to spin webs,—they merely throw out a few isolated threads. They are usually found on plants, tranquil and stationary; sometimes concealed between two leaves, of which they fasten the edges together. They watch their eggs with great care till the young are hatched.

Genus Micrommata. Sparassus, Walck.—Maxillæ straight, parallel, rounded on their edges. Eyes disposed four and four, on two transverse lines, of which the posterior is the longer, and arched backwards. The second and first pair of feet are the longest. The languette is semicircular.

Sp. Smaragdina.—Colour bright green, sides bordered with yellow. Abdomen greenish-yellow, with a darker green line upon the back.

This species places its cocoon in the centre of three or four leaves fastened together and lined with silk.

Genus Senelops, Dufour.—Maxillæ straight, or slightly inclined, without lateral sinus, pointed, and obliquely truncated on the internal side. Languette semicircular. Six eyes in front, on a transverse line; two others behind, one on each side. The legs are long; the first pair are the shortest.

Sp. Omalosoma.—Four lines in length, very flat, of a reddish-gray colour, with cinereous spots, and the feet ringed with black. The abdomen appears to present

posteriorly the vestige of rings or segments, forming a sort of dentation along the sides.

This rare species was discovered by M. Dufour in the kingdom of Valentia. It inhabits rocks, and runs with singular rapidity. It occurs both in Egypt and Syria.

Genus Philodromus, Walck.—Maxillæ inclined upon the languette, which is higher than broad. The eyes, nearly equal in size, are disposed in the form of a cross or semicircle. The mandibles are lengthened and cylindrical.

Sp. Tigrina.—Thorax very broad, flattened, of a reddish fawn-colour, brown laterally and posteriorly, white in front. The pentagonal abdomen variously coloured by means of minute red, brown, and white hairs, by which it is covered. It is bordered with brown along the sides, and is marked on the dorsal region with from four to six impressed points. The belly is whitish. The legs are long, slender, reddish, with brown spots.

This species is common on trees. When touched it immediately either runs off with great rapidity, or suddenly drops to the ground. Its cocoon, of a beautiful white colour, incloses about one hundred unagglutinated eggs. It places them in the clefts of trees, and guards them with great care.

Genus Thomisus, Walck.—Mandibles shorter than in the preceding genus, wedge-shaped. Four posterior feet, shorter than the others. The sexes frequently differ in their size and colours.

Sp. Citreus.—Colour citron-yellow. The abdomen large, broader behind; the back with two red spots. Inhabits flowers. The female is common in Britain; the male more rare, of a smaller size, brown, banded with yellowish-green.

B. Erraticæ.

The four preceding tribes are characterized by their usually sedentary habits. The remainder of the Araneides are of a more wandering disposition. This is in proper accordance with their other capabilities; for, as they cannot spin webs for the capture of their prey, they are under the necessity of moving about from place to place to extend the sphere of those exertions, the successful issue of which depends on agility as well as cunning. "Such," says Evelyn, "I did frequently observe at Rome, which, espying a fly at three or four yards distance, upon the balcony where I stood, would not make directly to her, but crawl under the rail, till, being arrived to the antipodes, it would steal up, seldom missing its aim; but if it chanced to want anything of being perfectly opposite, would, at first peep, immediately slide down again,—till, taking better notice, it would come the next time exactly upon the fly's back; but if this happened not to be within a competent leap, then would this insect move so softly, as the very shadow of the gnomon seemed not to be more imperceptible, unless the fly moved; and then would the spider move also in the same proportion, keeping that just time with her motion, as if the same soul had animated both these little bodies; and whether it were forwards, backwards, or to either side, without at all turning her body, like a well-managed horse; but if the capricious fly took wing and pitched upon another place behind our huntress, then would the spider whirl its body so nimbly about, as nothing could be imagined more swift; by which means she always kept the head towards her prey, though, to appearance, as immovable as if it had been a nail driven into the wood, till by that indiscernible progress (being arrived within the sphere of her reach) she made a fatal leap swift as lightning upon the fly, catching him in the pole, where she never quitted hold till her belly was full, and then carried the remainder home."[1]

Though the species above alluded to, and others constituting the ensuing tribes, spin no webs, they are yet provided with a sufficiency of the necessary material to enable them to construct cocoons for their eggs, and also to throw out an occasional thread to break their fall when leaping on a vertical surface.

The eyes of the erratic spiders are always eight in number, and are grouped rather along than across the thorax, forming a curvilinear triangle, or a truncated or quadrilateral oval. One or two pair of eyes are generally much larger than the others. The thorax is large, and the legs robust.

Tribe V.—Citigradæ.

In this tribe the legs are generally fitted for running. The maxillæ are always straight, and rounded at their extremities. The eyes are grouped in a curvilinear triangle, or in an oval or oblong figure, of which the anterior side is much narrower than the thorax taken in its greatest breadth. The thorax itself is ovoid, narrower in front, and somewhat ridged or keel-shaped in its longitudinal centre.

The females for the most part keep close to their cocoons, which they carry about them, either suspended at their extremities, or applied between the chest and the base of the abdomen. They watch over their young for some time after they are hatched.

Genus Oxyopus, Latr. Sphasus, Walck.—Eyes ranged two and two on four transverse lines, of which the two at the extremes are the shortest; they describe a kind of oval figure, truncated at each end. The languette is elongated, narrow at the base, dilated and rounded at the extremity. The first pair of legs is the longest; the fourth and second are nearly equal; the third is the shortest.

Sp. Variegatus.—Body hairy and gray, variegated with red and white. Legs pale reddish, spotted with brown; the tibial *spines* elongate. Inhabits France.

Sp. Lineatus. (Pl. XLVI. fig. 9.)—Abdomen elongated, yellowish, with lengthened black spots on the sides, and a black longitudinal band beneath. This species forms its web on low growing plants, but nestles among the leaves of trees about the period of laying.

Genus Ctenus, Walck.—Eyes placed on three transverse lines (2, 4, 2) forming a curvilinear triangle, reversed, and truncated anteriorly. The languette is square and almost isometric. The fourth pair of feet are the longest; the first pair are next in length; the third are the shortest.

This genus, according to Latreille, was established for the reception of a species found in Cayenne. Others, possessed of the same generic characters, have been found both in that colony and in Brazil, but their descriptions have not yet been made public.

Genus Dolomedes, Latr.—Eyes disposed on three transverse lines (4, 2, 2,) representing a quadrilateral figure, somewhat broader than long. The two posterior are

[1] Evelyn's *Travels in Italy.*

placed upon an eminence. The second pair of legs are equal to the first, if not somewhat longer; and the fourth pair are the longest of all. The languette is square, and, like that of the preceding genus, is as broad as high.

Of this genus, some have the two exterior eyes of the anterior line larger than the pair comprised between them; and the form of the abdomen is oblong oval, with a terminal point. The females construct a silken nest, funnel-shaped, or in the form of a bell, which they place in a thicket, or among leaves near the summit of a tree. In this they deposit their cocoons of eggs, of which they are exceedingly careful. When they leave their retreats, either to hunt for prey, or from any cause of alarm nearer home, they never fail to carry their bundle of eggs along with them. Clerk (*Aranei suecicæ*) mentions his having observed species of this genus spring with great activity upon flying insects.

Other species of Dolomedes have the four anterior eyes of equal size, and the abdomen oval, and rounded at the extremity. These inhabit the margins of water, run over the surface with agility, and even proceed a little beneath the surface without being wetted. The females form coarse irregular nets, suspended between the branches of plants, and place their cocoons upon them.

Sp. Mirabilis. Aranea saccata, Linn.—Colour pale reddish, covered with grayish down. Thorax heart-shaped, anteriorly abruptly sloping; the anterior angles and dorsal line whitish. Abdomen conical, suboval; darker on the back. Inhabits the woods of Europe. The female carries about her eggs inclosed in a dirty orange-coloured or whitish bag.

Genus Lycosa, Latr.—Eyes disposed in a quadrilateral figure, longer than broad, the posterior pair not placed on an eminence. The first pair of feet are sensibly longer than the second, but shorter than the fourth, which are the longest of all. The maxillæ are truncated obliquely at their external extremity. The languette is square, but rather longer than broad.

The species of this genus run swiftly on the ground. They live in holes, either previously formed by the accidents of nature, or hollowed out by themselves, and fortified along their interior walls by silken threads. Some dwell in the cavities of walls, where they form silken tunnels, covered externally by minute particles of earth and sand. In these retreats they undergo the periodical renewal of their skins; and also pass the winter, after having previously closed up the outer orifice of their dwellings. The females likewise deposit their eggs in these elongated cells. Their cocoons are usually fixed to the extremity of the abdomen, and when the mothers go abroad, they have thus no difficulty in carrying their eggs along with them. As soon as the young are hatched, they collect on the back of the female parent, and remain there till they gain sufficient strength to shift for themselves. The species are exceedingly voracious, and defend the possession of their domiciles with the greatest courage.

Sp. Tarentula. Aranea tarentula, Linn.—(Pl. XLVI. fig. 10.)—Colour ashy brown above; thorax with a radiated line, and margins griseous; abdomen marked anteriorly with trigonal spots, posteriorly with arcuate transverse streaks of black, bordered with white; beneath saffron-coloured, with a transverse black band; thighs and tibiæ beneath rufous white, with two black spots.

This species, an inhabitant of the south of Europe, is the celebrated tarentula, of which so many extraordinary accounts have been given by travellers. It is scarcely necessary to observe that these are fabulous. Its bite was said to produce symptoms equally severe with those of the most malignant fever, and of such a nature as to admit of being cured only by means of music. Some authors have even given a list of the tunes which are most efficacious in restoring the *tarentolati* (for so the patients were called) to health. The true tarentula occurs in the south of Italy, especially near the town of Tarentum, from which it has no doubt derived its name. It is the largest of the European species.

A species of this genus exists in the south of France, which bears a close resemblance to the Italian species, and appears to have been confounded with it by Olivier. It is the *Lycosa Melanogaster* of Latreille, and the *Tarentula Narbonensis* of Walckenaer, and differs from the species above described chiefly in being somewhat less, and in having the abdomen black beneath, and the edges only of a red colour.

Genus Myrmecia, Latr.—Eyes placed on three transverse lines; four in front, then two somewhat nearer the centre than the outer eyes of the first line, and two others behind the preceding pair. The mandibles are strong. The maxillæ are rounded and hairy at the extremity. The tongue is almost square, somewhat longer than broad. The feet are long, almost filiform, the fourth and first pair being the longest. The thorax appears as if divided into three portions, of which the anterior is the largest, and of a square form; and the others are hunched or knot-shaped. The abdomen is much shorter than the thorax, and is covered from its origin as far as the middle by a solid epidermis.

Sp. Rufa.—Length about six lines. Fulvous, shining, nearly smooth, with the extremities of the palpi, the thighs, the first article of the posterior feet, and the end of the abdomen, blackish. Found near Rio Janeiro.

Tribe VI.—Saltigradæ.

In this group the eyes are placed in a square figure, of which the anterior line extends along the breadth of the thorax. The thorax is demi-ovoid, or nearly square; flat, or but slightly bulged above; as broad before as elsewhere, and sloping suddenly down the sides. The legs are adapted both to running and leaping, and the thighs of the anterior pair are generally remarkably large and strong.

Several of the species construct among leaves and stones small oval sacks of silk, open at both ends, in which they seek refuge during bad weather, and while changing their skins. When any danger threatens these retreats they appear on the outside, and after a moment's reconnoitring run off with great agility. The females form small tents, which afterwards serve as cradles for their young, and where the mother and her progeny dwell for some time together. The males, in their battles with each other, exhibit many singular manœuvres.

The genus *Tessarops* of M. Rafinesque, and that of *Palpimanus* established by M. Dufour, both belong to this tribe. That first mentioned is said to have only four eyes. The latter is very rare, and was discovered in Valentia We are not yet acquainted with the characters of either

Genus Eresus, Walck.—Four eyes approached in a small trapezium, near the centre of the anterior portion of the thorax; and four others on its sides, forming a larger square. The languette is pointed and triangular. The tarsi are terminated by three crotchets.

Sp. Moniligerus.—Black; abdomen above cinnabar-coloured, with four or six black dots, arranged in two longitudinal lines; joints of the legs whitish; hinder sides of the thorax, the thighs, and the first joint of the four hinder legs, pale cinnabar. This is the *Aranea quadrigut-*

tata of Rossi's *Fauna Etrusca*. It inhabits France, Germany, and England.

GENUS SALTICUS, Latr. ATTUS, Walck.—Four eyes on a transverse line on the anterior portion of the thorax, the two intermediate larger than the others; the remaining eyes are placed two and two on each side of the thorax; they thus form a kind of parabola or part of a square, open posteriorly. The languette is very obtuse, and truncated at the summit. The tarsi have only two crotchets at their extremity. The mandibles of many of the males are very large. The shape of the thorax and the length and proportions of the legs vary according to the species.

Sp. Scenicus. Aranea scenica, Linn.—Black, margin of the thorax covered with white down; abdomen short ovate, covered above by a reddish white pubescence, with three transverse arcuate lines, and the termination white; the first band is basal and entire, the others acutely bent anteriorly, and interrupted in the middle.

This species is called in Britain the hunting spider. It occurs on walls and palings, and is a common species, of considerable beauty. It loves exposure to light and heat, and is frequently seen near windows in sunny weather. Its movements are lively and amusing. When it sees a fly or a gnat it moves towards it with a slow and gentle motion, and then springs upon it with a single rapid bound. It leaps upon its prey as securely down a perpendicular wall as on a horizontal surface, by means of a thread which, previous to each of its bounds, it has the precaution to attach to the plane of its position. The palpi of the female are whitish; her legs reddish-gray, with darker spots. The mandibles of the male are very large.

FAMILY II.—PEDIPALPI.

Palpi very large, extended in the form of arms, and terminated either by pincers or a claw. Mandibles with two fingers, of which one is movable. Abdomen composed of distinct segments, without any terminal spinners. Sexual organs at the base of the abdomen. Thorax consisting of a single piece, and presenting near its anterior angles three or two eyes, approached or in groups, and two other eyes close together in the centre of its anterior or posterior margin. Four or eight pulmonary sacks.

TRIBE I.—TARENTULÆ.

Our present division corresponds to the genus tarentula of Fabricius. The abdomen is attached to the thorax by a pedicle, or by a portion of the transverse diameter, without comb-shaped plates at its inferior base, or sting at its extremity. The stigmata are four in number, placed near the base of the abdomen, and covered by a plaque. The mandibles are terminated merely by a claw or movable crotchet. The languette is elongated, narrow, dart-shaped, concealed. Maxillæ two, formed by the first joint of the palpi. Eyes eight, of which three are disposed in the form of a triangle near each anterior corner, and two are placed upon a tubercle near the centre of the anterior margin.

Naturalists have as yet acquired but a slight knowledge of this tribe of Arachnides. They inhabit chiefly the warmest countries of Asia and America.

GENUS PHRYNUS, Olivier.—Palpi terminating in a claw. Body flat, thorax broad, crescent-shaped. Abdomen without a tail. The two anterior tarsi long, slender, antenniform.

This genus was named Tarentula by Fabricius, but we prefer retaining the name previously bestowed by Olivier, not only on account of its possessing a prior claim, but because the term Tarentula, as generally understood, applies to a spider of the genus *Lycosa*, the *Aranea tarentula* of Linnæus.

Sp. Lunatus. (Pl. XLVI. fig. 11.)—The arms or foot-palpi of this species are nearly three times the length of the body. They are unfurnished with spines, except at the extremity of the fourth article. This is the *phalangium lunatum* of Pallas. *Spicil. Zool.* fasc. 9. tab. fig. 5, 6.

Sp. Reniformis. Phalangium reniforme, Linn. Herbst. *Tarentula reniformis*, Fabr. (Pl. XLVI. fig. 12.)—Arms very spiny on their interior margins; the third and fourth articulations elongated. The fifth articulation is furnished with four spines. According to Maugé, this species is much dreaded by the negroes of the Antilles.

GENUS THELYPHONUS, Latr.—Palpi shorter and thicker than those of the preceding genus, terminated by pincers or double fingers. Body long, thorax oval, abdomen furnished with a slender articulated prolongation or tail. The anterior tarsi are short, with few articulations.

This genus appears to have been confounded by Gronovius with *Scorpio*, by Linnæus with *Phalangium*, and by Fabricius with *Tarentula*. It forms the passage in the natural progress of generic forms to the scorpion tribe.

Sp. Caudatus, Latr. *Phalangium caudatum*, Linn.—(Pl. XLVI. fig. 13.)—Some confusion seems to exist in regard to the exact or characteristic locality of this species. It is now said to occur in Java. South America furnishes another species, called by the inhabitants of Martinique *vinaigrier*, on account of its extremely acid odour.

TRIBE II.—SCORPIONIDES.

Abdomen sessile, or united to the thorax by its entire breadth, and furnished at its lower base with two movable comb-shaped plates, and terminated by a knotted base, armed with a sting at its extremity. Stigmata eight in number, four on each side along the belly. Mandibles terminated by two fingers, of which the exterior is movable.

The thorax of scorpions assumes the form of a lengthened square. There is a triangular appendage at the base of each of the four anterior feet, which in combination produce the appearance of a lip of four divisions; but of these, according to the views of Latreille, the lateral pair ought to be regarded as maxillæ, and the two others as forming the languette. The abdomen is composed of twelve articulations, including those of the tail, which are six in number. The first division of the abdomen is composed of two parts, the anterior of which bears the sexual organs, the posterior the comb-shaped appendages. These last-named parts are composed of a principal portion, narrow, lengthened, jointed, movable at its base, and furnished along its inferior side with a range of small, narrow, elongated, parallel plates, hollowed interiorly, united to the principal piece before mentioned, and somewhat resembling the teeth of a comb; their number seems to vary according to the species, and probably even with the age of the individual. The uses of these organs in the economy of the animal have not yet been determined. The four following segments of the abdomen have each a pair of pulmonary sacks and stigmata. Immediately behind the sixth segment the abdomen becomes suddenly narrow, and the six following knotty rings compose the tail, terminated by an arched slender point, beneath the extremity of which are two small holes, from which, at

the will of the animal, there flows a poisonous fluid, contained in an interior reservoir. The tarsi resemble each other, and are composed of three articulations, the last of which is armed with a pair of crotchets. The four posterior legs have a common base, and the first article of the haunches is as it were soldered; the posterior pair are in part joined by their back part to the abdomen.

Two nervous cords, which derive their origin from the brain or superior ganglion, unite at intervals and form seven other ganglia, of which the last belongs to the tail. In all other Arachnides, according to Latreille, the number of these ganglia never exceeds three.

Eight stigmata mark the position of an equal number of whitish purses, containing a great number of small delicate plates, among which it is believed the air permeates. A muscular vessel prevails along the back, and communicates by means of two other vessels with each of these purses. The intestinal canal is straight and slender. The liver is composed of four pair of glandular bunches, which discharge their fluid into the intestines at four points. The females are viviparous.

Scorpions occur in the warmer regions of Europe, Asia, Africa, and America. Several of the larger exotic species are poisonous, but the bite of the European kinds is rarely attended by fatal consequences, except to small animals. Maupertuis tried various experiments upon dogs and poultry with the scorpions of Languedoc. Only one dog died. The others, as well as the poultry, though repeatedly stung by *exasperated* scorpions, suffered no injury. Redi's experiments on pigeons were followed by a different result. They generally died in convulsions in about five hours after the infliction of the wound. Some, however, appeared to suffer no inconvenience from the bite of these animals. This difference may be attributed to the particular condition, or rather the quantity of the poison contained in the vessels at the time of the trial. The scorpions of Tuscany are so harmless that they are handled by the peasants without any fear.

Scorpions generally inhabit sombre and shady places, under stones, among old ruins, deserted dwelling-houses, and even, though more rarely, such as are occupied by man. They prey upon various kinds of insects, which they sting with their envenomed tails. They are very fond of the eggs of spiders and of insects. In running, they usually carry their tails curved forwards over their backs; and they possess the power of moving them in all directions, either as offensive or defensive weapons. We have already mentioned that they produce their young alive. Redi states the number of these to amount to between 26 and 40, but some species are more prolific. Maupertuis found from 27 to 65 in the bodies of those which he examined. They were suspended or connected by a lengthened thread, and each was inclosed in a very delicate membrane. The European kinds appear to produce in August, and are afterwards observed to change their skins. Some naturalists are of opinion that they couple twice a year. The female carries her young for several days upon her back, and watches over and defends them for about a month.

In the preceding generalities we have given the principal characters of the old genus scorpio. That genus has been recently divided into two, in conformity with the number of the eyes.

Genus Scorpio, Latr.—Eyes six.

Sp. Europæus.—Colour brown, varying in shade. Feet and terminal joint of the tail of a paler yellowish brown. Claws angular and heart-shaped. Pectens, or comb-shaped appendages, each with nine teeth.

The characters given by Linnæus to his S. Europæus do not accord with our observations on those found in France and Italy. "Cauda sub aculeo mucronata est." An American species is furnished with a projecting point *beneath the sting*, and the existence of that feature in the Transatlantic species seems to have induced De Geer to mistake the latter for the one described by Linnæus as inhabiting the southern countries of Europe.

Genus Buthus, Leach.—Eyes eight.

Sp. Occitanus. (Pl. XLVI. fig. 14.)—Colour yellowish or reddish. Tail rather longer than the body, with elevated and delicately granulated lines. Each pecten furnished with 28 teeth or upwards. About two inches in length.

This is the species experimented on by Maupertuis. He inclosed about 100 in one place, and after the lapse of a few days he found only 14 survivors, which had killed and eaten their companions. It occurs in France, Portugal, and Spain; likewise in Barbary.

Sp. Afer. (Pl. XLVI. fig. 15.)—Nearly half a foot long, and of a blackish-brown colour, with large heart-shaped claws, chagrined on their surface, and slightly haired. A notch in the anterior angle of the thorax. Number of teeth in each comb, thirteen. Occurs both in Africa and India.

Sp. Americanus.—Body slender, elongated, yellowish, with brown spots. Combs with twenty-eight teeth. Arms long and thin; claws filiform. Tail three times the length of the body. Sting with a point beneath. Inhabits America.

The *Scorpio dentatus* of Herbst is allied to the preceding. It inhabits Sierra Leone.

Order II.—Trachearíæ.

The Tracheal Arachnides are distinguished by their respiratory organs, which consist of radiated or branched tracheæ, receiving air only by two stigmatic openings. They possess no (ascertained) circulating system, and their eyes vary from two to four. Müller assigns six eyes to the *Hydrachna umbrata*, but Latreille is of opinion that some optical or other deception may have interfered with the usual accuracy of the great Danish naturalist. The respiration of the Pycnogonides is unknown, no stigmata having been observed in that family.

The Arachnides of this order are the smallest of their class. Some species are almost microscopical. They are naturally divided into two great divisions. Those which belong to the first are more nearly allied to the preceding order, the pulmonary Arachnides, in the form and structure of their masticating organs; such as pertain to the second have the parts of the mouth more simply constructed of certain parts, which, in union with the languette, constitute a kind of trunk or sucker. But many of the species are so minute, even in their general dimensions, that the examination of these organs, and the consequent classification of the species in accordance with a *cibarian* system, are attended with considerable difficulty, and, in the opinion of Latreille, ought not to be had recourse to, except in default of other more obvious characteristics.

The long-legged spider (commonly so called), which is a species of *Phalangium*, frequently met with in hay fields and other places during the summer season, is a familiar example of this order. So also are mites and other acarideous species.

Family I.—Pseudo-Scorpiones.

Thorax articulated, the anterior segment the larger. Abdomen distinct and annulated. Palpi large, in the form of feet or claws. Both sexes with eight feet, having two equal hooks at the end of the tarsi, the two anterior

sometimes excepted. Two mandibles (*antenne-pinces* or *chelicères* of Latreille) terminated by a couple of fingers; and two maxillæ formed by the first article of the palpi. This family consists of two genera, the habits of which are terrestrial; their bodies oval or oblong.

GENUS GALEODES, Oliv. SOLPUGA, Lichtenstein.

Mandibles very large, with vertical, strongly toothed fingers, of which one is superior, fixed, frequently furnished at its base with a slender pointed appendage; the other movable. Palpi large, advanced, in the form of feet or of antennæ, terminated by a short button-shaped article, vesicular and hookless. Anterior pair of feet resembling the palpi, but smaller; they are also hookless. Each of the other feet has the terminal joint of the tarsus furnished with a pair of hooks. The posterior pair of feet have five remarkable scaly excrescences placed upon foot-stalks, and ranged along the inferior surface of their first two articulations. The eyes, two in number, are very close to each other, and are situated on an eminence of the anterior portion of the first segment of the thorax, which presents the appearance of a large head bearing the anterior pair of feet, in addition to the masticating organs.

According to M. Dufour the terminal article of the palpi incloses a particular disc-shaped organ, of a whitish colour and pearly lustre, not visible externally unless the animal is irritated. The lip (*labre*) has the form of a small beak, much compressed, recurved, pointed, and hairy. The languette is small, keel-shaped, and terminates in two divergent threads, each placed on a small articulation. Latreille perceived a pretty large stigmatic opening on each side of the body, between the first and second feet, and another cleft at the base of the abdomen. The abdomen is oval and composed of nine rings. We lately received two species of this genus from Persia.

Sp. Araneoides, Olivier. (Pl. XLVII. fig. 1.)—*Solpuga Arachnoides*, Herbst.—Colour pale yellowish-brown. Inhabits Africa and the western countries of Asia.

GENUS CHELIFER, Geoff. OBISIUM, Illiger.—Palpi elongated, furnished with didactile pincers at their extremity. Eyes placed on the sides of the thorax. Legs nearly equal in size, each terminated by a pair of crotchets. Body flat. Thorax almost square.

These animals run swiftly, both backwards and forwards. They carry their eggs about with them after the manner of spiders. The elder Hermann is of opinion that they spin webs. Such of the species as have the thorax divided or impressed by a transverse line form the genus Chelifer of Dr Leach. Their eyes are two in number. Others have the thorax undivided, and of these the eyes amount to four. They form the genus Obisium of the last-named author.

Sp. Fasciatus.—Hands oval. Segments of the abdomen bordered with white. Lives beneath the bark of willow and other trees. Sometimes occurs near London. Leach, in *Linn. Trans.* xi.

Sp. Cancroides. (Pl. XLVII. fig. 2.)—This species measures about a line and a half in length. The body and legs are of a reddish brown. The palpi are about twice the length of the body. It is a European species, inhabiting old books, herbariums, &c. and preys upon the bodies of several destructive insects. It ought therefore to be cherished in the live state by collectors.

FAMILY II.—PYCNOGONIDES.

Trunk composed of four segments, occupying almost the entire length of the body, terminated at each extremity by a tubular article, of which the anterior portion, sometimes simple, sometimes accompanied by mandibles (*antenne-pinces*) and palpi, or by one or other of these organs, constitutes the mouth. Both sexes have eight feet proper for running; but the females are moreover provided with two false feet, placed near the anterior pair, and serving to carry the eggs.

The species of which this family is composed inhabit the sea. They usually keep themselves concealed among sea-weed along the shores, and feed upon small marine animals. Their movements are slow. Their bodies are generally linear, the legs very long, composed of from eight to nine articles, and terminated by two unequal crotchets, of which the smaller is cleft. The first articulation of the body, or that which represents the head and mouth, forms an advanced, nearly cylindrical tube, pierced at its extremity by a triangular opening. It also bears the mandibles and palpi. The former are linear or cylindrical, composed of two pieces, of which the last is pincer-shaped, with the inferior or fixed claw shorter than the other. The palpi are filiform, with a crotchet at the end, and composed of from five to nine articles. Each of the succeeding segments of the body, with the exception of the last, serves as a point of attachment to a pair of legs; and the segment which articulates with the mouth is provided on its dorsal portion with a tubercle bearing the eyes, and on its ventral portion (in the females) with a small additional pair of feet on which the eggs are distributed. The terminal segment is small, cylindrical, and pierced at its extremity. The stigmatic openings in the bodies of this family have not yet been discovered.[1]

M. Savigny is of opinion that this family forms the natural transition from the class Arachnides to the crustaceous tribes, and great uncertainty still prevails in the minds of naturalists regarding their true position in the system. We place them in the position which they now occupy in our present arrangement, in accordance with the views of M. Latreille. M. Milne Edwards, who has studied these animals in their native places, informed that celebrated entomologist, that in the interior of the Pycnogonides he observed cæca or lateral expansions of the intestinal canal.

GENUS PYCNOGONUM, Brunnich.—In this genus the mandibles and palpi are wanting, and the length of the feet scarcely exceeds that of the body, which is proportionally short and thick. The species are parasitical on cetaceous animals.

Sp. Balænarum. (Pl. XLVII. fig. 3.)—*Phalangium Balænarum*, Linn.—Inhabits the European Ocean. This species is frequently taken by the trawl-fishers in Plymouth Sound. It has been found by M. d'Orbigny on the coasts of France.

GENUS PHOXICHILUS, Latr.—In this genus the palpi are wanting, as in the preceding; but we observe a pair of mandibles, and a greater elongation of the legs.

To this genus belong *Pycnogonum spinipes* of the *Fauna Groenlandica*, *Phalangium hirsutum* of Montagu (*Linn. Trans.* ix.), *Nymphon hirtum* of Fabricius, &c.

GENUS NYMPHON, Fab.—Resembles the preceding genus

[1] Recent observations induce the belief that these creatures breathe through their skins,—a peculiar character, which, when satisfactorily established, may lead to their being erected into a separate order, intermediate in some respects between the Arachnides and the apterous insects of the parasitical order. (See *Règne Animal*, tome iv. p. 277, *note*.)

in the narrow and oblong form of its body, the length of its legs, and the presence of mandibles; but in addition to these organs there are likewise a pair of palpi.

Sp. Gracile, Leach. (*Zool. Misc.* i. 45.)—Colour cineıeous; thighs cylindrical. Inhabits most parts of the British seas. We are doubtful whether this species should be considered as synonymous with the *Nymphon grossipes* (*Phalangium grossipes*, Linn.) figured on Pl. XLVII. fig. 4. The term *grossipes* is certainly very inapplicable to either kind.

Genus Ammothea, Leach.—Mandibles much shorter than the rostrum, with equal joints, the fingers arcuate, and meeting at their tips. Palpi nine-jointed, the third joint very long. Legs slender; coxæ with the middle joint longest; tibiæ with the first joint rather the shortest; tarsi with the first joint small; claws double, unequal. Egg-bearing organs nine-jointed, inserted under the first legs, behind the rostrum.

Sp. Carolinensis. (Pl. XLVII. fig 5.)—Body entirely brown, testaceous; back with three trigonate tubercles. (*Zool. Miscell.* i. 34.) From South Carolina.

Family III.—Holetra.

The groups composing this family are characterized by the union of the thorax and abdomen in a single mass, beneath a common epidermis. The thorax is almost divided into two by a contraction; and the abdomen, in some species, presents the appearance of rings, formed by the folds of the epidermis. The anterior extremity of the body frequently projects in the form of a beak or muzzle. The generality are provided with eight feet; some have only six.

Tribe I.—Phalangita, Latr.

Mandibles very conspicuous, terminated by didactylous pincers. Palpi filiform, and composed of five articles, of which the last is terminated by a small nail. Two distinct eyes. Two maxillæ formed by a prolongation of the radical article of the palpi; and besides these there are sometimes four other jaws, which, however, result merely from a dilatation of the haunches of the first two pair of legs. Body oval or rounded, and covered, at least on the thorax, by a skin of a somewhat solid texture. The legs, which are always eight in number, are long, and distinctly divided, like those of insects. Many are provided near the origin of the two posterior legs with two stigmata, one on either side, concealed by the haunches. The species of this tribe are for the most part of active habits. The generative organs are placed internally beneath the mouth.

Genus Phalangium, Linn. Fab.—Mandibles projecting, much shorter than the head. Eyes placed upon a common tubercle. The feet are long and slender, and when separated from the body they for some time afterwards exhibit signs of irritability. The females are provided with a membranous oviduct, filiform, annulated, and flexible. The tracheæ are tubular.

The species of this genus are of predacious habits. They prey upon small insects, which they seize with their mandibles, pierce with their crotchets, and suck to death. They are of pugnacious tempers. Though analogous to spiders in their external forms, they cannot spin. They are short-lived, as those hatched in the spring are all supposed to die in the autumn.

Sp. Cornutum, Linn. (the male). *Opilio, ejusd.* (the female).—Body oval, reddish or ash-coloured above, white beneath. Palpi long. Two rows of small spines on the tubercle which bears the eyes. Thighs with prickles. Mandibles horny in the males. A blackish band with a festooned border on the back of the female.

Of certain species of this genus Mr Kirby has formed his genus *Gonoleptes.* (See *Linn. Trans.* vol. xii. Plate XXII. fig. 16.)

Genus Siro, Latr.—Mandibles projecting, almost as long as the body. Eyes distant, each placed upon an isolated tubercle.

Sp. Rubens. (Pl. XLVII. fig. 6.)—Colour pale red; legs paler. Dwells in moss at the roots of trees.

Genus Macrocheles, Latr.—Mandibles long and projecting. Eyes sessile, or none. Two anterior feet, very long, and antenniform. The upper part of the body forms a plaque or scale, without any distinct rings.

According to Latreille, the *Acarus marginatus* and *tes tudinarius* of Hermann (*fils*) belong to this genus.

Genus Trogulus, Latr.—Anterior extremity of the body advanced in the form of a hood or *chaperon*, and receiving in an inferior cavity the mandibles and other parts of the mouth. The body is very flat, and cover ed by a strong skin.

Sp. Nepæformis.—Colour obscure ash-colour. Central portion of the dorsal part of the abdomen, and the sides, obsoletely subcarinated. External apex of the first joint of the tarsi produced. Inhabits France and Germany, lurking beneath stones.

Tribe II.—Acarides.

Sometimes furnished with mandibles composed of a single pincer, didactylous or with a simple claw, and concealed in a sternal lip; sometimes furnished with a sucker formed of plates or laminæ joined together. A few have only a simple cavity for the mouth, without additional appendages.

The species of this tribe (corresponding to the genus *Acarus* of Linnæus) are almost microscopical, and are universally distributed. Some are erratic, and occur in a great variety of situations, among stones, on trees, among flour, cheese, and various other substances, whether animal or vegetable; others are parasitical on the skins of living creatures, which they sometimes greatly weaken by their excessive multiplication. The disease called itch, if not occasioned by, is at least in some way connected with, the presence of minute species of this family. Dr Galet has demonstrated that that disease may be communicated by the transmission of mites from one (infected) individual to another. Small mites have even been found in the brain and in the eyes of the human race.

Many of the species, when first produced, have only six feet. They are oviparous, and deposit a great number of eggs.

Genus Trombidium, Fab.—Mandibles *en griffe*, or terminated by a movable claw. Palpi projecting, pointed, with a movable appendage or finger at the extremity. Two eyes, each placed at the end of a small fixed pedicle. Body divided into two parts, of which the first or anterior is very small, and bears, besides the eyes and mouth, the first two pair of legs.

Sp. Holosericeum.—Of a blood-red colour. Abdomen almost square, narrower behind, and notched. Back furnished with papillæ, hairy at the base, and globular at their extremities. Common in gardens during spring.

Sp. Tinctorum. (Pl. XLVII. fig. 7.)—This species is three or four times larger than the preceding. It occurs in the East Indies, and produces a fine dye.

Genus Erythræus, Latr.—Mandibles and palpi as in Trombidium, but the body is undivided, and the eyes are not mounted on a pedicle.

Sp. Phalangioides.—Legs very long, the last joint broad, compressed. Body obscure red, with a dorsal band of orange yellow. Inhabits most European countries, running on the ground with great rapidity.

Genus Gamasus, Latr.—Mandibles didactylous; palpi projecting, distinct, filiform.

Some species of this genus have the upper surface of the body clothed, in whole or in part, with a scaly skin, while others are entirely soft.

Sp. Coleoptratorum.—Anterior pair of legs somewhat longer than the others. Coriaceous parts of the back fuscous.

Inhabits the excrements of horses and cattle, and is frequently found adhering in great numbers to the bodies of coleopterous insects of the genus Scarabæus, Hister, &c.

To this genus belongs the *Acarus marginatus* of Hermann, which is sometimes found in the brain (*corpus callosum*) of the human race.

Genus Cheyletus, Latr.—Mandibles didactylous. Palpi thick, arm-shaped, falcated at the extremities.

Sp. Eruditus. Acarus eruditus, Schrank.—Colour brownish. Inhabits books and museums.

Genus Oribata.—Mandibles didactylous. Palpi short and concealed. Body covered by a coriaceous or scaly skin, in the form of a shield or buckler. Legs long, or of medium length.

The body in this genus is prolonged anteriorly in the form of a muzzle. There is sometimes an indication of a thorax. The ends of the tarsi are terminated by a single crotchet in some, by two or three in others, without any vesicular ball or cushion. The species are found beneath stones, among moss, and on trees. Their movements are slow.

Sp. Geniculata.—Of a brownish chesnut colour, shining, hairy. Legs pale brown, thighs sub-clavate. Common in Sweden, Germany, and England.

Genus Uropoda, Latr.—Mandibles pincer-shaped; palpi not conspicuous. Body covered by a scaly skin, and terminated by a slender filament, by means of which the species adhere to the bodies of coleopterous insects.

Sp. Vegetans. (Pl. XLVII. fig. 8.)—Brown, smooth, and shining. Inhabits France and England, attaching itself to the legs and other parts of insects by its pedunculated anus.

Genus Acarus, Fab. Latr.—Furnished like the preceding genera with didactylous mandibles, and very short or concealed palpi; but the body is soft, and unfurnished with a scaly crust. The tarsi are provided at their extremity with a vesicular tuft. Many species live on the substances used as aliments by the human race.

Sp. Siro. The cheese-mite. (Pl. XLVII. fig. 9.)—Whitish, with two brown spots. Body ovate, the middle coarctate, with long hairs. Legs of equal length. Inhabits houses, feeding on flour and long-kept cheese.

Sp. Scabiei. (Pl. XLVII. fig. 10.)—A microscopical species, which inhabits the skin of man in a diseased state. It appears, from the observations of Bonnani and others, that this insect usually accompanies the disease called the *itch*.

Genus Bdella, Latr.—Palpi elongated, bent, terminated by hairs or bristles. Four eyes, posterior feet the longest. Sucker prolonged in the form of a conical or awl-shaped beak. Found in moss, beneath stones, and under the bark of trees.

Sp. Rubra. La Bdelle rouge of Latreille. (Pl. XLVII. fig. 11.)—Rostrum longer than the thorax. Colour coccineous, legs paler than the body. Dwells beneath stones. This is the *pince rouge* of Geoffroy, and the *Acarus longicornis* of Linnæus. It is a minute insect, measuring scarcely half a line in length.

Genus Smaridia, Latr.—Distinguished from the preceding genus by the palpi, which are scarcely longer than the sucker; straight, and without bristles at the extremity. Eyes two. Anterior pair of legs longer than the others.

Sp. Sambuci. Acarus Sambuci, Schrank.—Colour red, the body slightly haired. Movements slow. Dwells beneath the bark of trees, more especially that of the elder, observed by Latreille in the south of France. This genus is represented in Pl. XLVII. fig. 12., by a figure of *Smaridia passerina.*

Genus Ixodes.—Palpi inclosed in the sucker, along with which they form a short projecting beak, truncated, with a slight expansion at the end.

The animals of this genus occur among bushes and underwood, from which they detach themselves to fasten on dogs, sheep, cattle, and other quadrupeds, to which they adhere with remarkable tenacity. Their eggs, of which they lay a prodigious quantity, are, according to M. Chabrier, obtruded by the mouth.

Sp. Reduvius. Acarus reduvius, Linn. (Pl. XLVII. fig. 13.)—The colour and appearance of this species vary according to its state of repletion. The legs are black.

Genus Argas.—Palpi conical, composed of four articles, not inclosed in the sucker.

Sp. Reflexus. Acarus marginatus, Fab. (Pl. XLVII. fig. 14.)—Pale yellowish, or flesh-coloured, with deeper anastomosing lines. Inhabits houses in France, sucking the blood of doves.

A species of this genus found in Persia (the *malleh de mianeh*) is considered to be extremely poisonous. It appears, however, from the observations of M. Szovits, a naturalist recently employed by the Russian government to explore the Caucasus, that the bite of these bugs of Miana, as they are sometimes called (*Argas Persicus* of Fischer), is in reality by no means dangerous.

The three following genera correspond to the genus *Hydrachna* of Müller. Their habits are aquatic, and their forms oval, or nearly globular, and of a soft consistence. The number of their eyes varies from two to four, and even to six, according to Müller. They were usually confounded with the mites till the time of the last-named observer, who inferred that as they lived habitually in a different element, they ought to form a separate division. They resemble small spiders, and probably on that account received the name of Hydrachna, which signifies water-spider. Fabricius, who only employed in the formation of his groups characters drawn from the structure of the mouth, has united Hydrachna with Trombidium. The observations of Latreille have led not only to the distinct separation of these two genera, but to the subdivision of the genus Hydrachna into at least three distinct groups of species, all of which may be readily distinguished from the various kinds of mites (Acari) by their ciliated or natatorial legs.

The minute beings now under consideration occur

abundantly in stagnant or slowly moving waters. The spring season is the most favourable for the observance of their habits. They *run* through the water with great rapidity, with a continual movement of their legs. Their dispositions are carnivorous, and their food consists of animalcular species, of minute insects, small flies, and aquatic larvæ. Müller kept many Hydrachnæ in vessels of water full of *animalcula infusoria*, millions of which were eaten in a few days, soon after which the Hydrachnæ were found in a state of great languor, and transparent from exhaustion. They speedily revived when a few drops of water containing animalcules were mingled with that through which they swam.

The males are usually much less than the females, and the sexes frequently differ in colour. Only four or five species were known before the time of Müller, to whose persevering labours we owe the best elucidation which has yet been given of their history.[1]

Latreille is of opinion that the structure of the masticating organs authorizes the establishment of the three generic groups which follow.

Genus Eylais, Latr.—Mandibles terminated by a movable crotchet.

Sp. Extendens. Atax extendens, Fab. (Pl. XLVII. fig. 15.)—Body rounded, smooth, shining, immaculate, red. Hinder legs straight. Inhabits stagnant waters.

Genus Hydrachna, Latr.—Mouth composed of plates forming a projecting sucker. Palpi provided at their extremity with a moveable appendage.

Sp. Geographica. (Pl. XLVII. fig. 16.)—Black, marked with coccineous spots. Inhabits gently flowing waters. A beautiful species, not uncommon in several parts of Britain.

Sp. Cruenta. (Pl. XLVII. fig. 17.)—Distended, red; legs of nearly equal length. This is the *Trombidium globator* of Fabricius, and the *mite aquatique ronde* of De Geer.

Genus Limnochares, Latr.—Resembles Hydrachna in its sucker-shaped mouth, but the palpi are simple.

Sp. Holosericea.—Body ovate, red, rugose, soft; eyes black. This is the *Acarus aquaticus* of Linnæus, and the *mite satinée aquatique* of De Geer. Inhabits the waters of Europe, and occurs frequently in ponds during the summer months. It varies in colour from a bright red to a grayish red. According to Fabricius, it deposits its eggs on water scorpions (*Nepæ*).

The remaining genera are distinguished from all other Arachnides by having only six legs. Their habits are parasitical.

Genus Caris, Latr.—Sucker and palpi apparent. Body rounded, very flat, and covered by a scaly skin.

Sp. Vespertilionis.—Body fuscous. Found on bats.

Genus Leptus.—Sucker and palpi apparent. Body soft and ovoid.

Sp. Autumnalis. Acarus Autumnalis, Shaw. (Pl. XLVII. fig. 18.)—Colour red, very minute. Common during the summer months on grasses and other plants, from which it detaches itself, and fixing in the skin of the human species, occasions an insupportable itching. "Acarus Autumnalis," says Dr Shaw, "popularly known by the name of the harvest bug, is also one of the most minute of the genus, and is of a bright red colour, with the abdomen bent on its hind part, with numerous white bristles. This troublesome insect will make itself sufficiently known to most people, during the months of July, August, and September. It is easily distinguishable on the skin by its bright red colour, and adheres so tenaciously when it has once fixed itself, as to be scarcely separated without violence; its motion when disengaged is pretty quick, though by no means equal to that of some other acari. On the part where it fixes it causes a tumour, generally about the size of a pea, sometimes much larger, accompanied by a severe itching. These insects abound on vegetables, and are generally contracted by walking in gardens, amongst long grass, or in corn fields." (*General Zoology*, vol. vi. p. 464.)

According to Mr White of Selbourne, this minute creature greatly abounds in the chalky districts of Hampshire. He was assured that the warreners are much infested by them, and are sometimes thrown into fever by their bites. Another species is common on *Phalangium opilio.*

Genus Aclysia, Audouin.—Form like that of a bagpipe. A syphon, without distinct palpi, placed beneath the anterior extremity, which is narrow, curved, and obtuse. The legs are very small.

The species of this genus are parasitical on the bodies of water-beetles of the genus *Dytiscus.* The only one of which we have any knowledge (*A. dytisci*) is described by M. Victor Audouin, in the 1st vol. of the *Mém. de la Soc. d'Hist. Nat. de Paris.* We found it on *Dytiscus marginalis*, in the vicinity of Edinburgh. A second species has been recently discovered in Russia by Count Manheiren.

Genus Astoma, Latr.—Neither sucker nor palpi visible. The mouth consists merely of a small opening, situated in the breast. The body is soft, and oval; the legs very short.

Sp. Parasitica. (Pl. XLVII. fig. 19.)—Body coccineous, slightly contracted in the centre. This is the *mite parasite* of De Geer. It inhabits the bodies of flies and other insects.

Genus Ocypete, Leach.—This genus, arranged by Dr Leach in the same stirps as *Trombidium*, is placed by Latreille at the end of his Hexapod Arachnides. It differs from those with which it is conjoined by the possession of mandibles.

Sp. Rubra, Leach, *Linn. Trans.* xi.—Colour red, back furnished with a few long hairs. The legs are covered with many hairs of a rufous cinerescent colour. The eyes are blackish brown. This curious little animal, which is not larger than a grain of sand, is parasitical, and frequently occurs on the larger tipulæ, adhering to their legs. Dr Leach obtained no less than 16 specimens from one insect.

[1] See O. F. Müller's *Hydrachnæ*, 1 vol. 4to, 1781.

The following more special works may be consulted regarding the Arachnides, in addition to the general system in which they are treated of in their order of occurrence:—A Natural History of Spiders and other curious Insects. By Eleazar Albin. Lond. 1736. Aranei Suecici, descriptionibus et figuris æn. illustrati, &c. By Carolus Clerk. Holmiæ, 1757. Aranei, or the Natural History of Spiders, including the principal parts of the well-known work on the English Spiders, by Eleazar Albin; and also the whole of the celebrated publication on Swedish Spiders, by Charles Clerk, revised and enlarged, &c. By Thomas Martyn. 2 vols. Lond. 1793. Araneologie, oder Naturgesch. der Spinnen, &c. By Quatremère-Disjonval. Frankfurt, 1798. De l'Araneologie, ou sur la Découverte des Rapport Constant entre l'Apparition des Toiles et Variations Atmospheriques, &c. By the same. Paris, 1797. Description des Arachnides de l'Egypte. By Jul. C. Savigny. Paris, 1812. Exercitationes de Animalium Vertebris carentium in Ovo Formatione—P. 1st, De Generatione Aranearum in Ovo. By T. M. Herold. Marburgh, 1824. Arachnides. By Bory St Vincent. Extrait du 3e vol. de l'Encyclopedie Moderne. Paris, 1824. Die Arachniden. By C. W. Hahn. Nürnberg, 1831–35. Specimen acad. genera Araneidum Suesiæ Exhitens. By Carol. Sundevall. Lund. 1823. Conspectus Arachnidum. By the same. Goth. 1833. Die Arachniden. By C. L. Koch. Nürnberg 1836–46. Uebersicht des Arachnidensystems. By the same, 1837–43. Deutschlands Crustacean, Myriapoden u. Arachniden. By the same. Regensburgh, 1835–41. Tableau des Araneïdes. By C. A. Walckenaer. Paris, 1805. Histoire Naturelle des Araneides. By the same. Strasbourg, 1805–8. Histoire Naturelle des Insectes—Aptères, Arachnides. By the same. Tom. I. II., Paris, 1836–7. Tom. III., containing Phrynéides, Scorpionides, &c. By Paul Gervais. Paris, 1844.

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(J. W.)

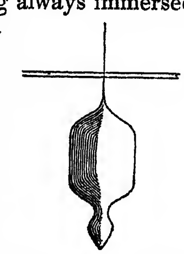
ARACHNOIDES, in *Anatomy*, an appellation given to several membranes,—as the tunic of the crystalline humour of the eye, the external lamina of the pia mater, and one of the coverings of the spinal marrow.

ARACK. See Arrack.

History. ARÆOMETER (composed of αραιος, *levis, tenuis*, and μετρον, *mensura*), a measure of the comparative density and rarity of bodies. The name does not occur in ancient authors; hydroscopium and baryllium being the ancient names of the instrument. This instrument was known in the civilized part of the Roman empire about the year 400, as appears from the fifteenth epistle of Synesius, addressed to Hypatia, daughter of Theon; and to Hypatia some modern writers have erroneously ascribed its invention. The instrument is also described in some verses annexed to Priscian; and the principles on which its operation is founded are to be seen in the treatise of Archimedes on floating bodies (*De Humido Insidentibus*). The term, as used by writers on natural philosophy, is chiefly applied to instruments which are made to float, so as to indicate the specific gravity of the liquids in which they are placed: the *pêse liqueur* and hydrometer, in common use for measuring the specific gravity of vinous spirits, are instruments of this kind.

Theory. A floating body displaces a portion of the liquid, the weight of which is equal to its own weight: the liquid acting upwards with a force equal to this weight, and the weight of the body acting downwards with the same force, equilibrium takes place. If the body be afterwards placed in a liquid of less density, the part of the body immersed will be greater than when the body was in the more dense liquid, because it requires a greater volume of this less dense liquid to equal the weight of the floating body. The absolute weights of two bodies being the same, their specific gravities are in the inverse ratio of their volumes $\frac{G}{g} = \frac{v}{V}$, when G is put for the specific gravity of the first body, g for that of the second; V for the volume of the first, and v for the volume of the second. On this principle the common hydrometer is constructed; the instrument described by Synesius is also of this kind. In order that a small difference in the volume immersed may be sensible, the part which is intersected by the surface of the fluid is in the form of a very slender cylinder, the great bulk of the instrument being always immersed in the liquid. At the inferior part is a small ball, containing mercury or small lead shot, which serves as ballast, bringing the centre of gravity low, so that the instrument may float erect, and without much lateral oscillation. The common hydrometers are made of glass, and sometimes of brass, or tin or pewter, and some have been made of amber as objects of curiosity. When made of glass, a scale, inscribed upon paper, is inserted in the cylindrical stalk: the division of the scale at which the surface of any liquid intersects the stalk, denotes the specific gravity of that liquid.

Aræometer with scale.

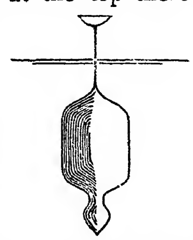


Mode of forming the scale. The divisions of the scale should be formed by immersing the instrument in liquids of known specific gravity, and marking a number corresponding to that specific gravity opposite to each division. The specific gravities of water and alcohol mixed in various proportions have been accurately ascertained by Mr

Gilpin. (See his Tables, and Dr Blagden's paper in the *Philosophical Transactions.*) On immersing the instrument in a mixture of known proportions of these two liquids, the point at which the surface intersects the stalk is to be marked with the number expressing the specific gravity of the mixture taken from the table. Some hydrometers, such as that constructed by the French chemist Beaumé, and which is much used in France under the name of *Aréomètre de Beaumé*, have the scale divided into equal parts, so that the divisions do not correspond as they ought to do with the numbers which express specific gravities.

Fahrenheit's.

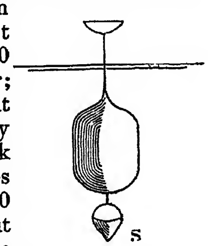
In the aræometer of Fahrenheit, the uncertainty arising from the erroneous division of the scale is obviated, no division being required. The form of the instrument is the same as that just described, only at the top there is a small cup, into which weights are put, so as to bring the surface of the denser liquid to a fixed mark on the stalk: when the instrument is placed in a liquid of less density, some of the weights are taken out till the mark again comes to the surface. Suppose the weight of the instrument and of the weights in the cup together equal to 1000, when sunk to the mark in



distilled water at a certain temperature; the instrument is now taken out of the water and immersed in a liquid, where 10 must be taken out of the cup in order to bring the mark to the surface; the immersion in water indicates that a volume of water weighs 1000; the immersion in the second liquid shows that an equal volume of this liquid weighs 990; when the volumes of bodies are equal, the specific gravities are directly as the absolute weights $\frac{G}{g} = \frac{W}{w}$, consequently the specific gravity of the second liquid is 990, that of water being 1000. To save computation, it is convenient that the whole weight of the apparatus, when in distilled water at a certain temperature, should be represented by 1000; for this purpose the instrument-maker divides the weight of the apparatus into 1000 parts, and forms small weights consisting of one, two, three, &c. of these 1000th parts, the relation of which to the ounce or pound does not require to be known; the weights thus formed are to be used with the instrument.

Nicholson's.

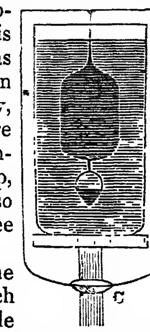
The aræometer of Nicholson is like that of Fahrenheit, with the addition of an immersed cup, whereby it is rendered proper for ascertaining the specific gravity of solids. Suppose that it requires 400 grains in the exterior cup to sink the instrument to the mark in distilled water, at 60 degrees of Fahrenheit's thermometer; 1*st*, The body under examination is put into the exterior cup, and weights (say 300 grains) are taken out till the mark again stands at the surface; this gives the absolute weight of the body 300 grains. 2*dly*, The body is then put into the immersed cup S, taking care



S

to brush off any air-bubbles with a hair pencil, and in order to bring the mark to the surface, a weight (say 100 grains) must be put into the exterior cup, that is, the weight of a volume of water equal to the body is 100 grains. The first part of the process gave the absolute weight of the body 300 grains; and the volumes being equal, the specific gravities are as the absolute weights; consequently the specific gravity of the body is 300, that of water being 100. This aræometer may be used to find the specific gravity of liquids: the process, in that case, is the same as that described above in speaking of the aræometer of Fahrenheit. The aræometer of Nicholson is useful to the mineralogist for ascertaining the specific gravity of minerals, the specific gravity being a convenient character for distinguishing one kind of mineral from another. It is sometimes made of tinned iron, but where more accuracy is required, copper is the material employed. When put together, it does not exceed a foot in length, and therefore is suited to form a part of the travelling mineralogist's apparatus.

Some aræometers have been constructed with the exterior cup C placed underneath, and supported by a stirrup, whose upper part is fixed to the stalk of the aræometer, as represented on the margin. This is done in order to place the centre of gravity low, that the aræometer may thereby float more steadily. The aræometer floats in a cylindrical vessel fitted to the size of the stirrup, and this vessel is supported on a stand so formed as not to interfere with the free motion of the stirrup.



C

Deparcieux's.

The aræometer of Deparcieux is like the common hydrometer, only the ball is much more voluminous. This renders it capable of indicating the small difference which exists in the specific gravity of the water of different springs, for which purpose Deparcieux proposed it. The dilatation of the large glass bulb by heat has a considerable effect on the operation of this instrument, and this dilatation being different in different instruments, renders the results inaccurate. The different aræometers above mentioned have the advantages of being easily made and easily carried about; but where the specific gravity of a body is required with the greatest accuracy, recourse must be had to the hydrostatic balance, which ought to be constructed with the utmost care by the most skilful artist.

The following algebraic expressions may serve to elucidate some of the properties of the aræometers hitherto spoken of:

g is the specific gravity of water, which is 1000 ounces when the ounce and foot are taken as unities, 1000 ounces avoirdupois being the weight of a cubic foot of water.

z is the diameter of the wire-stalk of the aræometer.

π is 3·1415, &c. the number expressing the periphery of a circle whose diameter is 1.

$\frac{1}{4}\pi z^2$ is the surface of a transverse section of the wire-stalk.

v is the volume of the bulb or body of the aræometer.

w is the whole weight of the aræometer.

x is the length of the stalk that is plunged in the water.

$\frac{1}{4}x\pi z^2$ is the volume of the immersed portion of the stalk.

When the aræometer floats in equilibrio, it displaces a volume of water equal to its own weight; therefore, $w = g\,(v + \frac{1}{4}\,x\pi v^2)$, and, $g = \frac{w}{v + \frac{1}{4}x\pi z^2}$, $x = \frac{4(w - gv)}{2g\pi z^2}$.

$w - gv$ is the difference between the quantity of water displaced by the whole aræometer, and the quantity displaced by the bulb alone; $w - gv$, therefore, is the volume of water displaced by the immersed portion of the stalk. As the diameter of the stalk z is very small, the cylinder of water $w - gv$, which has z for its diameter, is likewise very small, and does not exceed a few grains in weight; therefore a small variation in w (the weight of the aræometer), or in g (the density of the liquid), occasions a great variation in x (the length of the immersed part of the stalk). The value of x changes rapidly, when z (the diameter of the stalk) is changed,

Aræometer.

Sensibility to the specific gravity of liquid.

because the value of x is divided by z^2, which is the square of a very small quantity.

When the aræometer is immersed in a liquid of another specific gravity g^1, then the equation is $x^1 = \frac{2(w-g^1 v)}{g^1 \pi z^2}$; subtract the value of x^1 from that of x, and there results $x - x^1 = \frac{2w(g-g^1)}{gg^1 \pi z^2}$. This is the diminution in the length of the immersed part of the stalk, which takes place when the aræometer is transferred to a liquid of a greater density. By this formula it is seen, that the sensibility of the aræometer, that is, the length of the portion of the stalk which emerges upon transferring the aræometer to a denser liquid, is augmented, in the first place by increasing w (the weight of water displaced by the aræometer), that is, by increasing the volume of the body of the aræometer; secondly, by diminishing z (the diameter of the stalk), which is in the denominator of the value of $x - x^1$; consequently, the faculty of the aræometer to show the different densities of liquids is in general expressed by the fraction $\frac{w}{z^2}$.

With regard to the vertical mobility of the aræometer, when put in motion by placing a small weight s in its exterior cup, substitute $w+s$ for w; then, $x^1 = \frac{4(w+s-gv)}{2g\pi z^2}$. Take the difference between this and $x = \frac{4(w-gv)}{2g\pi z^2}$: this difference is $x^1 - x = \frac{4s}{g\pi z^2}$; which shows that the length of the portion of the stalk that a small weight causes to immerge is proportional to $\frac{s}{z^2}$, or in the direct ratio of the small weight, and in the inverse ratio of the square of the diameter of the stalk.

When the small weight, the density of the liquid, and the length of that part of the stalk which is submerged on adding the small weight, are known, then this equation will give the diameter of the stalk in known quantities $z = 2\sqrt{\frac{s}{g\pi(x^1-x)}}$.

When the weight of the whole aræometer is known in ounces, &c., and the specific gravity of one of two liquids (water, for instance) is known, the difference of specific gravity between that liquid and another liquid may be had in known quantities.

g is the specific gravity of water.

g^1 is the specific gravity of the second liquid, which is here supposed more dense.

w is the weight of the volume of water displaced by the aræometer.

s is a small additional weight placed on the exterior cup to keep the aræometer, when placed in the denser liquid, at the same point of immersion as when it floated in water.

$w+s$ is the whole weight of the apparatus when floating in the denser liquid.

The equation $g^1 = \frac{w+s}{v+\frac{1}{4}x\pi z^2}$ is obtained by substituting g^1 for g, and $w+s$ for w, in the equation $g = \frac{w}{v+\frac{1}{4}x\pi z^2}$, which was given above. Divide by $g = \frac{w}{v+\frac{1}{4}x\pi z^2}$, and there results $\frac{g^1}{g} = \frac{w+s}{w}$, which gives the proportion of the density of the second liquid to the density of water. By subtraction there results $\frac{g^1-g}{g} = \frac{s}{w}$ and $g^1 - g = \frac{sg}{w}$; that is, the difference between the density of the second liquid and the density of water is found by multiplying the small weight by 1000 ounces, and dividing this product by the number of ounces, &c. which denote the weight of the aræometer uncharged.

Aræostyle || Arafat.

Bead aræometer.

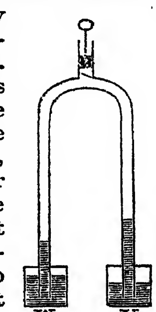
Small bodies, whose specific gravities are known, serve to indicate the specific gravity of a liquid in which they just remain suspended. In this way beads of glass three or four tenths of an inch in diameter are employed, each of which remains suspended in spirit of a certain specific gravity. The density of each of these beads, or rather bubbles, is regulated by the proportion between the quantity of glass and the cavity which the glass incloses. A piece of bees-wax, whose specific gravity, by the addition of lead, is such that the body is just suspended in brine of a known density, is used as an aræometer in some salt works. The fresh egg of a common fowl is just sustained by brine of a certain specific gravity, and is employed as an aræometer.

Homberg's.

The aræometer of Homberg consists of a phial with a slender neck and glass stopper, so made that it may be filled with the same volume of different liquids. It is employed in finding the specific gravity of liquids in the following way: 1*st*, The phial is filled with distilled water, and then weighed in a balance; 2*dly*, the phial is emptied, and again filled with the liquid whose specific gravity is sought, and weighed in a balance: the proportion of the weight of the contents of the phial in the second process to the weight of its contents in the first, is the specific gravity required. The inconveniences which have prevented this method from being generally used are, the difficulty of completely cleaning the phial from the liquid which it previously contained; the difficulty of filling the phial exactly with the same volume of each liquid; and the variation of the volume of the phial from changes of temperature.

Pump aræometer.

The pressure of the atmosphere supports columns of different fluids, whose height is inversely as the densities of the fluids. An aræometer has been constructed on this principle. It is a curved tube, one leg of which has its extremity immersed in water, and the other in the spirit whose density is to be tried. On rarefying the air in the tube, by means of a pump fixed at the upper part of the tube, the water ascends in one leg, and the spirit in the other; the height of the column of each liquid being measured by a scale of equal parts applied to each branch of the tube. This instrument has never come into use, probably on account of the difficulty of ascertaining with precision the points at which the surfaces of the columns are terminated.



(W.A.C.)

ARÆOSTYLE (ἀραίος and στῦλος), in *Architecture*, a term used by Vitruvius to signify the greatest interval which can be made between columns.

ARÆOSYSTYLE (compounded of the Greek words ἀραιός, σύν, στῦλος), in *Architecture*, an arrangement of columns in pairs, with an interval, usually equal to half a diameter, between the coupled columns, and an interval of three diameters and a half between the pairs.

ARÆOTICS (ἀραιωτικά), in *Medicine*, remedies which rarefy the humours, and render them easy to be carried off by the pores of the skin.

ARAFAH, the ninth day of the last month of the Arabic year, named *Dhoulhegiat*, on which the pilgrims of Mecca perform their devotions on Mount Arafat.

ARAFAT, a mountain near Mecca in Arabia, held in high

Aragon. veneration by the Mahometans. A visit to it constitutes a necessary part of the great pilgrimage. (See MECCA.) The mountain consists of a granite rock about 150 feet high, which is ascended by staircases, partly cut in the rock and partly composed of solid masonry. On this hill Adam is said to have met his wife Eve after a long absence; and it is thence called Arafat or *Gratitude*. On the summit is a chapel which the Mahometans believe to have been built by Adam. The interior was destroyed in 1807.

ARAGO, D. F. J. *See Sixth Preliminary Diss.* § 500.

ARAGON, or ARRAGON, a province, or, as it is usually denominated by the inhabitants of the peninsula, a kingdom, of Spain, and one of the component parts of that monarchy, situated between Lat. 40. 0. and 42. 51. N., and between Long. 2. 10. W. and 1. 45. E. It is bounded on the north by the Pyrenees, which separate it from France; east by Catalonia and Valencia; south by Valencia; and west by Navarre and the two Castiles. The length from north to south is 215 miles, and its breadth from 65 to 135 miles, with an area of 11,088 geographical square miles, and a population in 1849 of 847,105. In 1833 it was divided into the new provinces of Zaragoza, Huesca, and Teruel. The province is divided by the river Ebro into two nearly equal parts, which are distinguished as *Trans-ibero* and *Cis-ibero*. Its surface is very irregular: the western part, towards Old Castile, begins with the Sierra de Moncayo, but from the foot of these mountains to the Ebro the country is a continued level and fertile plain in the centre. To the south the ground rises gradually till it attains considerable elevation in the mountains near Cuença, in which are the sources of the most considerable rivers of Spain, some of which direct their courses to the Mediterranean, while otners force their way to the Atlantic. Mountains, branching from the Pyrenees, traverse the northern part, and it has likewise some mountains in the south; but these are of less elevation. The temperature of Aragon is extremely varied. In the north, near the Pyrenees, the climate is rigorous; while in the south, especially towards the Mediterranean, it is very mild.

The agricultural productions of the province necessarily vary with the variations in the elevation and aspect of the land. The greater part is appropriated to feeding flocks of Merino sheep, and their wool forms the most important of the productions of the province; in return for which they receive the manufactures of England and France. Wheat is grown more than sufficient for its own consumption, and it contributes to supply the neighbouring province of Navarre. Its wine and oil are generally more than its own demands require, and they are both of the best quality which Spain produces; but having none but difficult communication with any other country where these valuable articles are wanted, the cultivation of them languishes. Near the banks of the Ebro flax and hemp are grown in more than sufficient quantities for the domestic manufactures; and a supply of the latter is furnished to some of the maritime towns of Biscay, where it is preferred for cables to any other. The supply of horses and cows is not equal to the demands of the inhabitants, the deficiency being made up from the adjoining provinces. The mountainous parts abound with excellent ship-timber, but the badness of the roads prevents this branch of commerce from being carried on to any great extent.

The manufactures of the province are inconsiderable; that of silk, which was formerly extensive, has been gradually on the decline for some years. Manufactories for coarse cloths occupy the inhabitants of the city of Albarracin, and the large village of Tarazona; and some cloths of fine wool are made at Jaca, and some baize in its vicinity. Linen and sail-cloth are also made, but the quantity of each is small. There are iron manufactories on the mountains, where the abundance of trees calculated for making charcoal has introduced forges; but the badness of the roads checks their extension.

Aragon is not deficient in mineral riches, though the labour applied to them, as to most other objects in Spain, is in a very languid state. Near the Pyrenees, besides mines of iron, there are three mines of lead and one of copper, and, what is unique in Spain, a mine of cobalt. Besides these, there is a mine of alum near Alcaniz, which is very productive; and there are also quarries of marble and jasper.

At two leagues N.N.E. of Albarracin is the extraordinary fountain called Cella, at an elevation of 3700 feet above the sea. From this fountain the river Xiloca issues, and running through a beautiful country of 30 miles in extent, filled with inclosures, orchards, gardens, and vineyards, joins its waters, near Calatayud, to the more copious stream of the Xalon, which descends from Old Castile; and these united, lose their names by mingling their waters with the Ebro. Between the stream of the Xiloca and the mountains which separate Aragon from Molina, is a very extensive lake called Gallocanta, which covers about 6000 acres of land; and at a little distance from the lake are the ruins of the ancient city Bilbilis, which has derived celebrity from being the native place of the Roman poet Martial.

The principal river of Aragon is the Ebro, to which most of the other rivers in the province are tributary. (See EBRO.) The soil is generally dry; but the valleys are usually well-watered and fertile. The Imperial Canal of Aragon, which extends in the direction of the Ebro from Tudela almost to Sastago, is about eighty miles in length, nine feet in depth, and has an average breadth of sixty-nine feet. It is navigable for vessels of from 60 to 80 tons burthen. This great work was commenced by Charles V. in 1529, but remained unfinished for nearly 200 years.

The capital of Aragon is Zaragoza, a city of more than 40,000 inhabitants; for the description of which, with its memorable resistance to the French invaders, see ZARAGOZA. The other considerable cities and towns are Teruel, Daroca, Calatayud, Borja, Tarazona, Alcaniz, Caspe, Barbastro, Monzon, Huesca, and Jaca. At the most western part of the province a district called Cinco-villas is remarkably fruitful. The whole extent of 17,000 acres derives its fertility principally from an artificial canal, cut for the purpose of irrigation, called the royal canal of Tauste, by means of which the whole of the land may be flooded at pleasure.

The name of this kingdom was derived from the small but precipitous torrent Aragon, which rises in the Pyrenees, and, running from north to south, falls into the Ebro.

A great portion of the Pyrenees is in the province of Aragon. They run from east to west, presenting towards Spain the convex part of a kind of spherical segment, losing their height gradually towards each extremity. The highest point of this range of mountains, called by the French Mont Perdu, and by the Spaniards Monte Perdido and Las Tres Sorores, is visible from the city of Zaragoza. According to the actual measurement of the naturalist Ramond, who reached its summit in 1802, it is 11,430 feet above the level of the sea. Its top is constantly covered with snow, the permanent limits of which, on the same authority, are stated at 7750 feet of elevation. Before the measurement of Ramond, the point called Canigu was supposed to be the highest peak of this range, but it was thereby ascertained to be but 10,050 feet high.

There are at least fifty passes through the Pyrenees from France into Spain, but few of these are practicable except for the peasantry. The regular carriage roads over these mountains are the following:—1. The *Col de Pertus*, between Perpignan and Jonquera; 2. The pass of *Puy Moriens*, between the valley of Sagre and that of the Ariège; 3. The *Port de Confranc*, between Zaragoza and Pau; 4. The *Port de Roncevaux*, between Pamplona and St Jean; 5. The pass of *Bedassoa*, between Vittoria and Bayonne. From an accurate survey by the French engineers, it appeared there were upwards of eighty practicable passages,

of which twenty-eight would allow of cavalry, and seven of artillery and wheel-carriages. None of these had been ever examined by the Spanish government, though it was more than suspected that a very considerable contraband traffic had been conducted through these passes, in spite of the vigilance of the officers of revenue in both kingdoms.

Previous to the reign of Ferdinand and Isabella the political constitution of Aragon was the most liberal in Europe. Formally monarchical, its genius and maxims were purely republican. The kings, who were long elective, retained only the shadow of power; while its real exercise was in the hands of the Cortes; an assembly consisting of the nobility, the equestrian order, the representatives of the cities and towns, and the ecclesiastical order.

No law could pass without the assent of every member who had a right to vote. Without the permission of the Cortes no tax could be imposed, war could not be declared, nor peace concluded. Besides these, and other extraordinary privileges enjoyed by the Cortes, the Aragonese possessed another safeguard against despotic power in the election of a *Justiza*, or supreme judge, who acted as the guardian of the people, and the controller of the prince. He was the supreme interpreter of the laws, and was accountable to the Cortes alone for the manner in which he discharged the duties of his high office.—See *Robertson's History of Charles V.*, vol. i. § 3.

The history of Aragon before its union with Castile by the marriage of Ferdinand and Isabella, when it was merged in the kingdom of Spain, will be found in the general history of that country. It had, before this epoch, a succession of twenty sovereigns, from the year 1035 to 1516.—See *Zurita, Anales de Aragon; Viage de* Ponz; *Geografia de* Don Isidoro de Antillon; *Historia de la Economia Politica de Aragon*, por Don Ignacio de Asso.

ARAGONA, a town of Sicily, situated on a hill, seven miles N.N.E. of Girgenti. It is ill-built, but has some curious antiquities, and an old castle containing a fine gallery of pictures. In its vicinity is the celebrated mud-volcano of Maccaluba. Pop. 6500.

ARAGONITE, a carbonate of lime, with a small quantity of carbonate of strontia in its composition. See MINERALOGY.

ARAHAL, a town of Spain, in the province of Sevilla, 7 leagues south-east of the city of that name. The population, amounting to about 7000, is chiefly agricultural.

ARAL, a vast lake or inland sea, in Asia, about 200 miles eastward of the Caspian, between Lat. 40° and 47° N. Long. 57° and 61° E. Its form is irregularly oblong, extending from N.N.E. to S.S.W., about 290 miles by 130 from W. to E. It is separated from the Caspian by a plateau of the moderate elevation of 700 feet above that sea. Its western shores are steep and rocky; the southern and eastern are low and sandy, interspersed with marshes. Its waters are saline, but are readily drunk by horses. It abounds with the same species of fish as are found in the Caspian; and in both is found a species of seal which M. Vallenciennes has lately characterized as a peculiar species, different from the *Phoca Vitulina* of Linnæus and Pallas. In winter it is partially frozen, so that persons pass on the ice from the mouth of the river Sir to the town of Kourgrat. This sea receives two large rivers, the Amur, anciently the Oxus, from the west, and the Sir or Jaxartes from the east. Its name, in the language of the Kirghese-Tartars, is *Aral-Denghis*, or Sea of Islands, a group of which were described by the Russians in 1850 as near the middle of the sea, and have been named the Isles of Nicholas I., Constantine, Bellinghausen, and Lazareff. The level of the surface of this lake, compared with the Caspian and Black Sea, has not been well ascertained. Some barometrical measurements, little to be trusted, made its surface about 117 feet above the Caspian; but later, and seemingly more accurate observations, with the same instrument, reduce this difference to 34 feet. Indeed M. Von Humboldt is inclined to think that the surfaces of both seas are on the same level, and both on the same vast *Aralo-Caspian* depression of the Asiatic continent, which he reckons to occupy "a space of 18,000 square geographic leagues; that is to say, 900 square leagues greater than France, with a depression of about 81 English feet below the level of the Black Sea."—(*Asie Centrale*, ii. 311.) (T. S. T.)

ARALIACEÆ, a natural order of plants, of which the genus Panax is the chief. The Ginseng of the East is *P. fruticosa*, and there are several species of Panax in the New World and in Australia.

ARAM, the name given by the Hebrews to the extensive territory lying between Phœnicia, Palestine, Arabia Deserta, and the Tigris, and the mountain-range of Taurus. Aram, or Aramæa, seems to have corresponded generally to the Syria and Mesopotamia of the Greeks and Romans.

ARAMAIC LANGUAGE. This was divided into two dialects—the western and the eastern; the former is the Syriac, and the latter is the Chaldaic or Babylonic. Both, though nearly dead tongues, are yet used by some tribes about the ancient Aram, and in the hills near Mosul; and it was the most common dialect of the Jews after the Babylonian captivity till their dispersion by the Romans.

ARANDA DE DUERO, a town of Spain, in the province of Burgos, on the right bank of the river Duero. Pop. 4200. Long. 3. 40. 34. W. Lat. 41. 40. 12. N.

ARANGOES, pierced beads of rough carnelian, of various shapes and qualities, formerly imported from Bombay in considerable quantities for re-exportation to Africa. The best are barrel-shaped, from two to three inches long. Since the abolition of the slave-trade few have been imported.

ARANJUEZ (the ancient *Ara Jovis*), a town of Spain, in the province of New Castile, 28 miles S.S.E. of Madrid. It is situated in a fertile and well-watered valley on the left bank of the Tagus, immediately above the junction of that river with the Xarama, in Lat. 40. 1. 54. N. Long. 3. 37. 30. W. It is usually the residence of the Spanish Court from Easter till the end of June, during which time the population is increased from 4000 to about 12,000. The town is built in the Dutch style, with avenues of trees, and has numerous hotels, public gardens, theatres, and other places of amusement. The palace was begun by Philip II. and enlarged and embellished by his successors. The gardens are much admired for their rural beauties, fine shaded walks, fountains, and cascades. During the Peninsular war, this place suffered severely from the French. The treaty of 1772 between France and Spain, by which they pledged themselves to assist each other in opposing the English in America, was concluded here; and here, on the 18th of March 1808, broke out the insurrection which ended in the abdication of Charles IV. in favour of his son Ferdinand.

ARARAT (Turkish *Aghur Tagh*, Armenian *Macis*), a famous mountain of Armenia, at the point where the territories of Persia, Turkey, and Asiatic Russia meet—its principal summit being in Lat. 39. 42. N., Long. 44. 35. E. It consists of two immense conical masses, the summits of which, according to Parrot, are seven miles apart. They differ considerably in elevation, the summit of the Greater Ararat being 17,323 feet above the level of the sea, and 14,300 above the plain, while the Lesser Ararat is only 13,093 feet above sea level. The loftiest peak is covered with perpetual snow, which, however, does not form a glacier, and it reaches no lower than 14,100 feet above the sea. On the other summit it only lies from the end of October to the beginning of September. Ararat is isolated, except on the north, where it is connected with a chain extending along the valley of

the River Aras towards Erzeroum. It is a volcanic mountain; but there was no record of an eruption until 1840, when a vast column of vapour, mingled with dark smoke, was observed to proceed from a chasm on its flank to a great height; and an undulating motion of the earth, lasting only about two seconds, rolled from the mountain to the east and south-east. The village of Arguri and the monastery of St. James, with their inhabitants, were buried under the mass of stones and mud that was thrown out. This mountain is generally supposed to have been the place where Noah landed from the ark after the waters of the Flood had abated. The Jews, in the first century of the Christian era, identified the Ararat of Genesis with Armenia. The Armenians revere Mount Macis as the place of descent, and the Persians call it Koh-i-Nuh, or Noah's Mountain. Several attempts have been made to reach the top of Ararat, but few persons have succeeded in getting beyond the limit of perpetual snow. This is said to have been accomplished in 1829 by a German in the employment of Russia, and more recently in 1845 by Professor Abich; but the natives stoutly deny that either of these gentlemen reached the summit. In July 1856 a party of five English gentlemen succeeded in performing this feat.

ARAS, the ancient Araxes, a large river of Armenia, rises near the city of Erzeroum, and the sources of the Phrat or western branch of the Euphrates, and flows eastward for about 500 miles, when it joins the Kur. It is a very rapid and muddy river, with steep banks that prevent its waters being used for the purpose of irrigation. About 200 miles from its source it is joined by the Arpa-chai.

ARATUS, the son of Clinias, was born at Sicyon about 271 B.C. On the murder of his father by Abantidas, he was rescued from a similar fate by the care of a relative who conveyed him to Argos. At the age of twenty, with the assistance of some Argians, he deposed the tyrant Nicocles, and thus, without bloodshed, restored freedom to his native Sicyon. In 245 he was elected chief of the Achæan League, which office he frequently held in subsequent years; and he was mainly instrumental in confirming that great confederation which restored the liberties of Greece. (See Achæans.) In Aratus were combined many private virtues with splendid abilities; but he was more eminent as a statesman than as a general; for in his wars with the Ætolians and Spartans he was frequently unsuccessful. He died at the age of 58, as commonly reported by poison administered to him by the order of Philip of Macedon; but the symptoms of his disorder afford no certain grounds for such an assumption. His countrymen paid divine honour to his memory; and two yearly festivals (*Arateia*), were celebrated at Sicyon, one to commemorate his birth, the other his deliverance of the city from tyranny.—Plutarch, *Aratus* and *Agis;* Polybius ii. iv. vii. viii.

Aratus, a Greek poet, born at Soli, or Solæ, a town in Cilicia, which afterwards changed its name, and was called Pompeiopolis in honour of Pompey the Great. He flourished about the 124th, or, according to some, the 126th Olympiad, in the reign of Ptolemy Philadelphus, king of Egypt. He discovered in his youth a remarkable poignancy of wit, and capacity for improvement; and having received his education under Dionysius Heracleotes, a Stoic philosopher, he espoused the principles of that sect. Aratus was physician to Antigonus Gonatas, the son of Demetrius Poliorcetes, king of Macedon. His poem, entitled Φαινόμενα, describes the nature and motion of the fixed stars, and shows the particular influences of the heavenly bodies, with their various dispositions and relations. He wrote this poem in Greek verse. It was translated into Latin by Cicero, who tells us, in his first book *De Oratore*, that the verses of Aratus are very noble. This piece was translated by others as well as Cicero, there being a translation by Germanicus Cæsar, and another into elegant verse by Festus Avienus. An edition of the *Phænomena* was published by Grotius at Leyden, in quarto, in 1600, in Greek and Latin, with the fragments of Cicero's version, and the translations of Germanicus and Avienus; all which the editor has illustrated with curious notes. A valuable edition was published at Oxford, by Fell, in 1672, in 8vo; but the most complete is that of Buhle, published at Leipsic in 1801, in 2 vols. 8vo. There were several other works ascribed to Aratus, none of which have come down to us: Hymns to Pan; Astrology and Astrothesy; a composition of Antidotes; an Ἐπιθυτικόν on Theopropus; an Ἠθοποιά on Antigonus; an Epigram on Phila, the daughter of Antipater and wife of Antigonus; an Epicedium of Cleombrotus; a Correction of the Odyssey; and some Epistles in prose. Virgil, in his Georgics, has imitated or translated many passages from this author; and St Paul has quoted a passage of Aratus. It is in his speech to the Athenians (Acts xvii. 28), wherein he tells them that some of their own poets have said, Τοῦ γὰρ καὶ γένος ἐσμέν, For we are also his offspring. These words are the beginning of the fifth line of the *Phænomena.*

ARAUCANIA, an independent territory of South America, between Lat. 37. and 39. 50. S. and Long. 70. and 75. 20. W. It is bounded on the north by the river Biobio, which separates it from Chili, south by the Valdivia, east by the Andes, and west by the Pacific Ocean.

The Araucanians are remarkable for the fierce and almost uninterrupted struggle they have maintained for upwards of 300 years against the encroachments of the Spaniards on their territory. They are of moderate stature, strong, muscular, and well-built, with a light copper complexion, lank hair, oval faces, prominent cheek-bones, the nose somewhat flat, the eyes small, and expressive of vivacity. Their general aspect indicates some degree of sternness and resolution; they are bold and intrepid in war, patiently enduring fatigue, and fearlessly exposing their lives.

The country is divided into four tetrarchies, each governed by a *Toqui.* Each tetrarchy is divided into five provinces, governed by an *Apo-ulmen*, and each of the provinces is subdivided into nine districts, severally presided over by an *Ulmen.* The *Toquis* are independent of each other, but form a federal union for the public welfare. They have no maintenance from the state, nor are their subjects bound to render them any kind of personal service, except in time of war. A great council, composed of *Toquis*, *Apo-ulmens*, and *Ulmens* is convened upon any emergency. In time of war, a commander-in-chief is chosen, generally from the *Toquis*, but should none of them possess the requisite qualifications, one of the inferior rulers is elected. The others swear obedience to him, and furnish him with their contingent of men. Before the arrival of the Spaniards their army of course consisted of infantry only; but they soon saw the value of cavalry, and in a short time they could muster a considerable body of horse. The cavalry are armed with lances and swords; the infantry with pikes and clubs mounted with iron. Formerly they used the sling and bow, but these were soon laid aside. Every soldier is the rightful possessor of the booty he can seize; but a fair division is made of the plunder taken in common, the toqui himself receiving no larger share than a private soldier.

Their religious system is somewhat similar to their political government. They believe in a supreme Being, whom they call the Spirit of Heaven, and who is the great toqui of the universe. Under this spirit there are *apo-ulmens*, or inferior deities, and in the lowest rank are *ulmens* or genii. They have no temples, idols, or priests, and only sacrifice on solemn occasions. They believe in the immortality of the soul. Polygamy prevails among them; a man being allowed as many wives as he can purchase. Their principal

wealth consists in flocks and herds, and their industry is confined to husbandry. See AMERICA, CHILI.

ARAUCARIA, a beautiful genus of the Coniferæ. It differs from other firs by its broad shining leaves. The first species was found in the mountains of Araucania; and the two other known species are found in various parts of South America, and in some islands in the Pacific. *A. excelsa* grows freely in sheltered situations in Britain, where it is called *Norfolk Island Pine*.

ARAUSIO, *Civitas Arausiensis* or *Arausicorum*, or *Colonia Secundanorum;* so called, because the veterans of the second legion were there settled; now *Orange*, in the west of Provence, on an arm of the river Aigues. See ORANGE.

ARAVULLI, a range of mountains in Rajpootana, extending about 300 miles from north-east to south-west, where they are separated from the Vindhya mountains by the valley of the river Mhye. The Aravulli form a series of ridges, covering a breadth of from 6 to 60 miles, with a general elevation of 3600 feet. They rise abruptly from the western desert, but fall gradually towards the east. Their general geological character is of primitive formation, with rocks of granite, compact dark blue slate, gneiss, and sienite; and the summits of the diverging ranges, west of Ajmere, are quite dazzling, says Colonel Tod, not with snow like the Himalayas, but with enormous masses of vitreous rose-coloured quartz. To the north of Komulmair, 25° north latitude, two of their ridges form a continuous table-land between them, 6 to 20 miles in width, as far as Ajmere, where it breaks up from the tabular form, and sends off numerous branches of low rocky hills, through Jeypour and Alwar, which reach the Jumnah in the vicinity of Delhi. That part of the range between Komulmair and Ajmere, called Mairwarra, or the region of hills, is inhabited by the Mairs, a branch of the Mairas, one of the aboriginal tribes of India, who have lived for ages by robbery, being at constant war with their Rajpoot neighbours. They have yielded, however, to British influence, and give fair promise of becoming a civilized and industrious people.

ARBACES was governor of Media under Sardanapalus king of Assyria. Disgusted by the effeminacy of the king, he stirred up his people to revolt, and dethroned Sardanapalus, who thereupon burnt himself in his palace. Arbaces founded the monarchy of the Medes, which lasted 317 years under eight kings, till Astyages was expelled by Cyrus. Arbaces reigned 28 years, and died B.C. 848. (Diodorus, ii.) Herodotus gives a different account; but the authority of Ctesias, whose original work has perished, is followed by most ancient historians. (V. Paterculus i. 6; Justin, i. 3; Strabo, xvi. 737.)

ARBALEST, or CROSS-BOW. See CROSS-BOW.

ARBE, anciently ARBA, an island and city of Illyria, in the Gulf of Quarnaro. Of this island, which has been but slightly noticed by geographers, there is a full account in the Abbé Fortis's *Account of Dalmatia.* The appearance of the island is exceedingly pleasant. On the east it has a very high mountain, at the foot of which the rest of the island is extended to the westward, and divided into beautiful and fruitful plains interspersed with little hills fit to bear the richest products. At the extremity that looks to the north a delightful promontory, called Loparo, stretches into the sea: it is crowned with little hills, which almost inclose a fine cultivated plain. Near this promontory are the two small islands of S. Gregorio and Goli. The city stands between two harbours on a rising ground almost peninsular.

ARBELA, now ARBIL or ERBIL, a town of Asiatic Turkey, to the east of the Tigris, in Long. 44. 5. E. and Lat. 36. 11. N., 40 miles east of Mosul. It appears to have been once a very large town, but is now quite decayed. It is built on an artificial mound, about 150 feet high, surrounded by a wall inclosing about a thousand houses, and there are about 500 more at its foot. Its inhabitants are Kurds and Turks. It is famous in history as having given its name to the last decisive battle, B.C. 331, between Alexander the Great and Darius Codomannus, the last king of Persia. The battle was fought in the plain of Gaugamela, fifty miles distant, and Alexander pursued the fugitives to Arbela. See GREECE.

ARBERG, a town of Switzerland, in the canton of Bern, with a handsome castle, where the bailiff resides. It is seated on the river Aar, in a kind of island; and since 1830 has been fortified. Long. 7. 15. E. Lat. 47. 0. N. Pop. 850.

ARBITRARY, that which is left to choice or arbitration, or not fixed by any positive law or injunction.

ARBITRARY *Punishment*, in *Law*, denotes such punishments as are by statute left to the discretion of the judge. It is a general rule in arbitrary punishments, that the judge cannot inflict death. Hence all punishments that are not capital have acquired the name of *arbitrary punishments*, even although they be expressly pointed out by statute.

ARBITRATION, a term derived from the nomenclature of the Roman law, and applied to an arrangement for taking and abiding by the judgment of a selected person in some disputed matter, instead of carrying it to the established courts of justice. Arrangements for avoiding the delay and expense of litigation, and referring a dispute to friends or neutral persons, are a natural practice, of which traces may be found in any state of society; but it is to the Justinian jurisprudence that we owe it as a system which has found its way into the practice of European nations in general, and has even evaded the dislike of the English common lawyers to the civil law. The eighth section of the fourth book of the Pandects is devoted to this subject, and may be consulted through the commentary of Heineccius, or a more minute critical inquiry by Gerard Noodt, in his commentary on this section (Opera, ii. 135). Almost all the advantages, as well as the defects of the system in modern practice, seem to have been anticipated by the Roman jurists. Thus it is shown that voluntarily selected judges can only properly decide questions which the parties themselves could settle by giving and taking, and that they ought not to be authorized to deal with criminal inquiries or public questions; while, by excluding matters of personal status, such as marriage or legitimacy, the Roman jurists anticipated the principle, that even private questions which may affect the public morals or policy cannot be thus extrajudicially disposed of. They dwell on the principal advantage of the system in excluding appeal from the arbiter's decision on any such ground as erroneous law, or false views of the influence of well-investigated facts. But, on the other hand, they discuss, with their usual scientific subtlety, the many defects, such as excess of authority, neglect of form, and partiality in receiving pleadings or evidence, and the like, by which arbitrations become vitiated; and thus these jurists at once suggest what is ever the defect of a system of arbitration, that the more it performs its function of doing justice, the more it becomes what the established tribunals of the country ought to be, and fosters two systems of judicature where one should be sufficient. Some of the civilians make a distinction between the *arbitrator*, the name technically applicable to a person voluntarily chosen by parties to decide disputes, and the *arbiter* an officer to whom the prætor remitted questions of fact as to a jury. In this sense arbiters appear to have been employed as a substitute for jury trial in some of the old provincial laws of France; and hence, perhaps, it comes that, by a very remarkable provision in the French code of commerce, all questions between partners touching the partnership must be referred to arbitration. In the code of civil procedure, the title *des arbitrages* is treated so fully and minutely, as very forcibly to convey the impression of a separate system of voluntary jurisdiction being created for performing what ought to be accomplished by the ordinary tribunals in a well-regulated judicial system. In Scotland, the practice of arbitration has been

imported from the Roman law without requiring, as in England, statutory intervention. From the peculiarities of the Scottish system of registration, the decree-arbitral, or decision of the arbiter, when recorded in pursuance of the consent of the parties in their contract of arbitration, or submission, can be enforced as the decree of a court. (J. H. B.)

ARBITRATION, in the *Law of England* (according to Blackstone), is "where the parties, injuring and injured, submit all matters in dispute, concerning any personal chattels or personal wrong, to the judgment of two or more *arbitrators;* who are to decide the controversy: and if they do not agree, it is usual to add, that another person be called in as *umpire* (*imperator*), to whose sole judgment it is then referred: or frequently there is only one arbitrator originally appointed." The decision must be in writing (unless otherwise expressly provided in the submission), and is called an *award;* and thereby the question is as fully determined, and the right transferred or settled, as it could have been by the agreement of the parties or the judgment of a court of law or equity.

There were, however, many inconveniences attending this mode of proceeding; and in the year 1698, the legislature accordingly interfered and passed the act 9th and 10th Will. III., cap. 15, which enacted that, "for promoting trade, and rendering the awards of arbitrators the more effectual in all cases, for the final determination of controversies referred to them by merchants and traders, or others, concerning matters of account or trade, or other matters;" all merchants and others, desiring to end any controversy, suit, or quarrel (for which there is no other remedy but by personal action or suit in equity), by arbitration, may agree that their submission of their suit to the award or umpirage of any person shall be made a rule of any of the courts of record, and may insert such agreement in their submission; which agreement being proved by the affidavit of one of the witnesses thereto, the court shall make a rule that such arbitration or umpirage pursuant to such submission shall be conclusive; and, after such rule made, the parties disobeying the award shall be liable to be punished, as for a contempt of court; unless such award shall be set aside, as procured by corruption or undue means in the arbitrators or umpire, to be proved on oath to the court, before the last day of the next term after the award is made.

An application for an attachment for not performing an award, may be resisted at any time for defects appearing on the face of the award itself; for such an award, after that time, might be pleaded in bar to any action brought upon it, although it cannot be *set aside* for such defects after the end of the next term. Submissions of disputes to arbitration may be by consent of the parties, or with the interposition of a court of justice; by rule of court, or order of a judge, when a cause is pending, either by bond, agreement in writing, or by parol. A verbal agreement, however, to abide by an award cannot be made a rule of court. Nor can matters purely criminal be submitted to the decision of an arbitrator. And by the 12th and 13th Vict. c. 45, §§ 12–15, the provisions of the former statutes as to arbitrations are extended to "controversies and disputes, for which the remedy is by appeal to a court of general or quarter sessions of the peace." Lastly, although the right of real property cannot pass by a mere award, yet if a party be awarded to convey land, and refuse, he will be liable to an action, or to an attachment for not performing the award.

The agreement of reference must be expressed with great care and accuracy;—provisions should be inserted giving power to either party to make the submission a rule of court, to enable the court to refer the matter back to the same or to another arbitrator; and in case of the death of either party before award, for its making and delivery to his representatives; and also as to the costs, which are usually directed to be in the discretion of the arbitrator as to those of the reference, and as to those of the cause to abide the event of the award; and a certain day should be appointed on or before which the arbitrator is to make his award, with a power to such arbitrator to enlarge the time.

When arbitrators have the power of electing an umpire, they may choose him, and call in his assistance as soon as they begin to take the subject into consideration; and this is the more convenient practice, as it secures a decision upon a single investigation of the controversy.

As to the award; it must be in pursuance of the submission, and embrace all the matters submitted, and not extend beyond it in the subject-matter, in persons, in time, or in particular circumstances; it must be certain; it must make a final end and determination of all matters contained in the submission; it must be mutual, that is, it must not be entirely of things to be performed by one party, without such things being in satisfaction of the matters in difference; and finally, it must not be unreasonable, illegal, or impossible to be effectuated.

Formerly, a submission to arbitration, being a mere authority, might be revoked at any time before execution, by an instrument of as high a nature as that by which the submission was created. But now, by the Law Amendment Act (3d and 4th Will. IV., cap. 42), the submission to arbitration by *Rule of Court*, or *Judge's order*, or *order of Nisi Prius*, or if there be an *agreement to make the submission a Rule of Court*, cannot be revoked by any party thereto, without leave of the court or a judge. The death, however, of either party, before award is a revocation of the authority, unless otherwise provided in the submission; and so also is the marriage of a female before award; the marriage operating as a civil death to all her rights as a *feme sole.*

Under this statute the attendance of witnesses, or production of documents before the arbitrator, may be compelled by a rule of court, or order of a judge, on payment of expenses and loss of time; and the arbitrators are empowered to administer oaths to the witnesses, where it is so agreed or ordered by the rule or order of reference. Any witnesses failing to attend are deemed to be guilty of contempt of court, or giving false evidence guilty of perjury.

The court or judge may also, in the cases within the statute, enlarge the time for an arbitrator to make his award.

As to the mode of enforcing an award, see ATTACHMENT. (R. M—M.)

ARBOIS, a town of France, department of Jura, formerly Franche-Compté, famous for its wines. Pop. 6370. Long. 5. 47. E. Lat. 46. 55. N.

ARBON, a town of Switzerland, canton of Thurgau, chief of the circle of the same name. It contains 1100 inhabitants, and has some trade in cotton goods. It is on the Lake of Constance. Long. 9. 25. E. Lat. 42. 27. N.

ARBOR, in *Mechanics*, the axis or spindle of a machine, as of a crane or a windmill. Also that part of a machine which sustains the rest.

ARBROATH, or ABERBROTHOCK, a seaport and manufacturing town of Scotland, in the county of Forfar, 17 miles north-east of Dundee, 15 miles E.S.E. of Forfar, and 60 miles N.N.E. from Edinburgh, situated on the North Sea, at the mouth of the river Brothock, 12 miles north-west of the Bell-Rock lighthouse, in Lat. 56. 34. N. Long. 2. 35. W.

Arbroath was early celebrated for its abbey, founded by William the Lion in 1178, and dedicated to the famous Thomas à Becket, archbishop of Canterbury. It was created a royal burgh in 1186, and the charter was renewed in 1589. King John of England granted it very unusual privileges; for, by charter under the great seal, he exempted it *a teloniis et consuetudine* in every part of England, except London. The founder of this abbey was buried there, but there are no remains of his tomb. The monks belonged to

the Tyronensian order, and came from Kelso, the abbot of which place declared them to be free from his jurisdiction. In 1320, a convention of the Scottish nobles was held in this abbey by Robert I., where a letter was addressed to the pope, praying him to admonish and exhort Edward II. not to invade their territory. This letter is remarkable for the spirit and independence of its style, considering the time and circumstances under which it was written.—See Hailes' *Annals of Scotland.*

In 1394, an agreement was entered into by John Geddie, the abbot, and the burgesses of Arbroath, by which the former obliged himself and his successors to maintain a sufficient harbour at their own expense. The last abbot was the too famous Cardinal Beaton, at the same time archbishop of St Andrews. This abbey, like many other buildings of the same class, fell a sacrifice to the zeal of the Reformers in 1560; but its former magnificence and splendour are attested by the remains of its walls, cloisters, towers, piers, and the fine window of the chancel.

At the commencement of the eighteenth century, Arbroath was a place of little importance, but it has gradually been enlarged and improved, and is now a flourishing town, with considerable manufactures of hemp and flax. The principal manufacture is that of linen, which gives employment to a great part of its population. It has seventeen spinning mills, several bleach-works, two tanneries, two iron founderies, several ship-building yards (with a patent slip), rope-works, and breweries. Among its public buildings are the town-hall, prison, trades-hall, and the parish church, to which a handsome spire 150 feet high has lately been added; two chapels of ease, three Free churches, an Episcopal, a Catholic, an Independent, and several Secession chapels. It has three branch banks, a savings bank, three news rooms, a subscription and a mechanics' library, and an academy. A weekly newspaper, the *Arbroath Guide,* is published on Saturday. During the course of last century, the Abbot's harbour was superseded by a more commodious one a little to the west of the other, which has lately been much enlarged and improved at a cost of L.50,000. A neat signal tower 50 feet in height, with an excellent telescope, communicates with the Bell-Rock lighthouse; and on its north pier is a fixed red light, at an elevation of 24 feet, which is visible eight miles off. Its imports are hemp, flax, vitriol, manganese, coal, &c.; its exports, paving-flags, barley, potatoes, fish, &c. In 1849, there were 116 vessels, of the aggregate burden of 12,609 tons, belonging to the port; and in that year the gross amount of customs' duty received at its port was L.13,946, being upwards of L.2000 above that of the preceding year. It is connected with Forfar by a railway, which also unites it with the Scottish Midland and the Aberdeen lines; and it communicates with Dundee by the Arbroath and Dundee Railway. The municipal government is vested in a provost, two bailies, a treasurer, a dean of guild, and twelve councillors; and it has seven incorporated trades. Arbroath unites with Forfar, Montrose, Brechin, and Bervie, in sending a member to parliament. By the census of 1851, Arbroath had 1737 inhabited houses, and 17,008 inhabitants. The market-day is Saturday; and fairs are held on the last Saturday of January, the first Saturday after Whitsunday, the 1st of July if a Saturday, or on the first Saturday thereafter, and the first Saturday after Martinmas.

ARBURG, or Aarburg, a city of Switzerland, in the circle of Zoffingen, and canton of Aargau. It stands at the confluence of the rivers Aar and Wigger, and has been almost entirely rebuilt since its destruction by fire in 1840. In 1850 it contained 1650 inhabitants, who manufacture cotton goods and hosiery. Conspicuous on the height above is the citadel, built in 1660, now a military storehouse.

ARBUTHNOT, Alexander, principal of the university of Aberdeen in the reign of James VI. of Scotland, was born in the year 1538. He studied first at Aberdeen, and was afterwards sent over to France, where, under the famous Cujacius, he applied himself to the study of the civil law. In the year 1563 he returned to Scotland and took orders. Whether he was ordained by a bishop or by presbyters is a matter of uncertainty. In 1568 he was appointed minister of Arbuthnot and Logie Buchan; and in the following year Mr Alexander Anderson being deposed, he was made principal of the King's College at Aberdeen in his room. In the General Assembly which met at Edinburgh in the years 1573 and 1577 he was chosen moderator, and to the end of his life was an active supporter of the Reformed religion. He died in 1583, in the forty-fifth year of his age, and was buried in the College church of Aberdeen. It was by him that Buchanan's *History of Scotland,* published in 1582, was edited. The only production of his own is his *Orationes de Origine et Dignitate Juris,* printed at Edinburgh in 1572, 4to. His contemporary Thomas Maitland wrote a copy of Latin verses on the publication of this book: they are printed in the *Delit. Poet. Scot.* The same collection contains an elegant epitaph on him by Andrew Melvil.

Arbuthnot, *John,* M.D., the son of an Episcopal clergyman in Scotland, was born soon after the Restoration, at Arbuthnot, near Montrose. Having gone through a course of academical studies and obtained the degree of doctor of physic at Aberdeen, he went to London, where he began to display his talents in teaching mathematics, in which he was well skilled. *An Examination of Dr Woodward's Account of the Deluge,* &c., in 1697, first made him known to the learned world. This performance was received with great applause; and in 1700 a treatise *On the Usefulness of Mathematical Learning* increased his reputation. A very interesting paper *On the Regularity of the Births of both Sexes,* demonstrating from authentic proofs the universal similarity which is observed by nature in this circumstance, and drawing from these several political and moral inferences, which he presented to the Royal Society, procured his election in 1704 into that body. Meanwhile he was acquiring considerable eminence in his own profession, and was appointed physician extraordinary to Prince George of Denmark, and shortly afterwards one of the physicians in ordinary to Queen Anne. He was admitted in 1710 a fellow of the college. He formed about this period a very intimate acquaintance with Pope, Gay, and Swift, which lasted with unabating affection during the rest of his life. In 1714, in co-operation with Pope and Swift, he engaged in writing a satire upon all the abuses of science in every branch, under the form of the history of a fictitious character, and in the grave ironical style. The plan was never finished, but the *Memoirs of Martinus Scriblerus,* published in Pope's works, form a part, of which much is the performance of Dr Arbuthnot. It is very probable that the whole of the first book is of his composition, in which the profound knowledge that is displayed, and the good-natured pleasantry with which the satire is directed, has gained it the character of one of the most original, learned, and interesting pieces in the English language. Those parts which relate to anatomy, the manners and customs of antiquity, and logic, are particularly his performance.

On the death of Queen Anne, which was a serious blow to his personal and political views, Arbuthnot visited Paris, where he spent some time. On his return he retired from St James's, where his services were no longer required, and attended to the practice of his profession. His literary pursuits were carried on at the same time with undiminished ardour, though considerable intervals elapsed between the publication of his works. A work entitled *Tables of Ancient Coins, Weights, and Measures,* explained and exemplified in several dissertations, appeared in 1727, in a 4to volume,

which is the chief of his serious performances. Although there are inaccuracies in it which could hardly be avoided in so intricate a subject, it is a work of great merit, and is still considered as a standard authority, though the more recent work of Hussey is generally preferred. A treatise *On the Nature and Choice of Aliments*, which was published in 1732, and another published in 1733, *On the Effects of Air on Human Bodies*, finish the list of his acknowledged works. Respecting his humorous works, which were the productions of his leisure hours, they are so confounded with those of his contemporaries, that it is not easy to distinguish them. But a piece which, independent of any other, would rank him among the best humorous writers in the English language, entitled the *History of John Bull*, is confidently ascribed to him. It is written with great wit and humour, and all the circumstances and characters are most admirably adapted. Among his several avowed ironical pieces are, *A Treatise concerning the Altercation or Scolding of the Ancients*, and the *Art of Political Lying*.

In the year 1751 there were published two small volumes, entitled *The Miscellaneous Works of Dr Arbuthnot;* but the greater part of what they contain is denied by his son to be of his composition. Through all his pieces of this kind there runs a vein of good-natured pleasantry; and this tends to confirm the character given of him by Swift, "He has more wit than we all have, and his humanity is equal to his wit."

In these occupations he passed his days, amid all the pleasures that can render domestic life happy, in the affection and estimation of his friends, beloved and esteemed by all his literary associates, who have each taken great pains to celebrate their mutual friendship. Swift, in one of his poems, sincerely laments that he is

> Far from his kind Arbuthnot's aid,
> Who knows his art, but not his trade.

Pope has dedicated to him an epistle called a *Prologue to the Satires*. Of his two sons, he witnessed the death of one; and the other, with several daughters, survived him. At length, from an inveterate asthma, he fell into a dropsical disorder; and in order to try the effect of a change of air, he repaired to Hampstead, though without any hope of recovery. Returning to his house in London, he died February 27, 1734–5.

ARBUTUS, a genus of the natural order Ericaceæ, and some of them very ornamental shrubs in our pleasure grounds. This is especially the case with *A. Unedo*, a plant indigenous in southern Europe, which stands our British climate well, attaining a height of 20 feet, and bears a berry somewhat resembling a strawberry. A specimen of *A. Andrachne*, even higher still, remarkable for the iron-brown colour of its epidermis, which it annually sheds, is growing in the open air at Otterspool near Liverpool.

ARC, Joan of (*Jeanne d'Arc*), generally called the *Maid of Orleans*, one of the most famed heroines in the annals of history, was born about the beginning of the fifteenth century at Domremy, near Vaucouleurs, in Lorraine, where her father, a peasant named Jacques d'Arc, resided. When she was able in the least degree to earn a sustenance for herself, her parents, who were poor, put her to service at a small inn, where she performed several offices more properly belonging to the other sex, such as riding the horses to water, and attending them in the fields, and many other similar services. At the time when Charles VII. was reduced to a very low condition, and the greatest part of his country had been overrun by the English, Joan, probably then at the age of 27 or 28, imagined herself favoured with heavenly visions, in one of which she was commanded by St Michael to go immediately to the relief of Orleans, at that time closely besieged by the English army, and then to procure the consecration of the king at Rheims. In February 1429 her parents took her to the governor of Vaucouleurs, named Baudricourt, who at first held her pretended inspiration to be no more than an idle tale, and treated it with contempt; but at last, induced by her entreaties, he sent her to Chinon, where the king then was, in order that she might be introduced to him. Charles, that he might test her alleged powers, determined to present her to a company of his nobles, where no mark of dignity tended to distinguish him from them; and it is asserted that she immediately recognized him, and informed him of secrets which he had endeavoured to conceal from every person. She boldly engaged to accomplish the two objects of her mission, and required that they should arm her with a consecrated sword which lay in the church of St Catherine of Fierbois; and although she had never seen it, she accurately described every particular concerning it. The manner in which she acted inspired many with confidence; and certain doctors of the church were appointed to examine into the nature of her inspiration, and matrons to give proofs of her virginity. The report which they gave was very favourable; but being next put into the hands of the parliament, they treated her as frantic, and demanded that she should show them a miracle. She answered, that although she had not any at that time to present, she would soon accomplish one at Orleans. At length being fully armed and mounted, she was sent to Orleans along with the army destined for its relief. Her exemplary enthusiasm reanimated the soldiery, and the camp was soon freed from disorder and intemperance. Entering Orleans, she introduced a convoy; and boldly attacking the English in their forts, she routed them with great slaughter, and struck them with such a panic that they were even obliged to raise the siege with precipitate haste. The dignity of a superior mind and an exalted heroism reigned through all her actions. Various other successes followed in a short time, and the dismayed English everywhere fled before the hand of a conquering enemy whom they had but lately contemned. Joan now thinking it proper to perform her other promise of crowning the king at Rheims, proceeded with him as he marched through the kingdom, in order to receive submission of the towns, which he did without any opposition. Arriving at Rheims, the keys of the city were delivered to him; and, entering the town, he was anointed with the holy oil of Clovis, and crowned, Joan standing by his side in full armour, and displaying her consecrated banner. Charles filled with gratitude for her important services, ennobled her family, and conferred upon it the title of *the Sys*, with an adequate estate in hand. The two objects of her mission being now accomplished, Joan prepared to retire into the country; but Dunois, the general, being sensible of her importance on account of her pretended inspiration, endeavoured to persuade her to remain in arms until the English should be fully driven from the country; which by his persuasions he effected. Advised by him, she cast herself into Compiegne, then closely besieged by the English and the Duke of Burgundy. Having there made a sally upon the enemy, she drove them from their intrenchments; but being basely deserted by her followers, she was taken prisoner. The English, with a malignant spirit of revenge, resolved to show no mercy to their heroic captive. The Duke of Bedford the regent, having ransomed her from the captors, appointed a criminal prosecution against her, upon the charges of employing sorcery and magic, and of being impious. He was joined in the accusation by the clergy, and by the university of Paris. Joan was carried in irons before an ecclesiastical commission at Rouen, where several capricious interrogatories were put to her during a trial of about four months, to which she answered with steadiness and gravity. Among several other questions, she was interrogated why she had assisted at the coronation of Charles with the standard in her hand. She boldly replied, "Because the person who shared in the danger had a right

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to share in the glory." Her defence was not so strong concerning her pretended inspiration and visions, which were the most dangerous points of the attack. She appealed to the pope upon being accused on these grounds of impiety and heresy, but her appeal was not allowed. At length she was condemned of being a blasphemer and sorceress, and accordingly delivered over to the power of the civil magistrate. A view of the dreadful punishment that awaited her at last overpowered her resolution, and she endeavoured to escape it, by making a disavowal of her pretended revelations, and a full renunciation of her errors. Her sentence was then changed into perpetual imprisonment; but this punishment did not assuage the fury of her barbarous enemies. They craftily laid a man's dress in her chamber; and Joan, induced by the sight of an apparel in which she had gained so much honour, put it on; and upon being discovered, her enemies condemned her to the stake, interpreting the action into a relapse of heresy. She suffered her punishment in June 1431, at the market-place of Rouen, with great firmness; and even the English themselves beheld the scene with tears. Her unjust and cruel death was an indelible stigma on the character of her prosecutors. Charles did nothing towards avenging her cause; but ten years afterwards contented himself with procuring the restoration of her memory by the pope, and a reversion of the process. She was styled in that act a "martyr to her religion, her country, and her king." In their enthusiastic admiration, her countrymen were not so slow in honouring her memory. Many marvellous stories were related by them concerning her death. Some supposed that she was not actually dead, and continually expected that, as formerly, she would come, and at their head lead them on to victory. A consistent and uniform judgment respecting the actions and address of this personage cannot be made by posterity. That she gave herself up to the influence of a heated fancy, and that she was confident in the idea of her divine inspiration, and that this notion was so improved by certain favourites of Charles as to excite the emotions of the public, seems to be the most probable supposition.

Arcade ‖ Arch.

ARCADE, in *Architecture*, is used to denote any opening formed by an arch in the wall of a building.

ARCADIA, a very mountainous country in the centre of Peloponnesus, bounded on the north by Achaia, east by Argolis, west by Elis, and south by Messenia and Laconia. Its greatest length was about 50 miles, and its breadth from 35 to 41 miles. The Alpheus and its tributaries were its principal rivers. The Arcadians derived their origin from the eponymous hero Arcas; and they are called by the Greek writers autochthones, or aborigines. Their great tutelary deity was Pan, who presided over rural affairs. The Arcadians were a simple and frugal people, and especially fond of music, which they cultivated with great success. When the rest of Peloponnesus was conquered by the Dorians, they maintained their independence. They were originally governed by kings; but about the year 670 B.C. they abolished monarchy, and their several cities—the most important of which were Mantinea, Orchomenus, Tegea, Pheneos, and Psophis—became independent republics. The Arcadians joined the Achæan League, and finally submitted to the Romans.

ARCESILAUS, a celebrated Greek philosopher, about 300 years before the Christian era, was born at Pitane, in Æolis. He founded the New Academy, called also the *Second* or *Middle* school. He was a man of great erudition, and had many disciples. The middle school laid it down as a principle, that we could know nothing, nor even assure ourselves of the certainty of this position; from whence they inferred that we should affirm nothing, but always suspend our judgment. They held that a philosopher was able to dispute upon every subject, and bring conviction with him, even upon contrary sides of the same question; for there are always reasons of equal force both in the affirmative and negative of every argument. According to this doctrine, neither our senses nor even our reason are to have any credit; and therefore, in common affairs, we are to conform ourselves to received opinions. Arcesilaus died in his 76th year in a fit of intoxication, and was succeeded by his disciple Lacydes, who met a similar fate.

ARCH.

Arch defined.

1. Arch, in *Building*, is an artful disposition and adjustment of several stones or bricks, generally in a bow-like form, by which their weight produces a mutual pressure and abutment; so that they not only support each other, and perform the office of an entire lintel, but may be extended to any width, and made to carry the most enormous weights.

History of architecture connected with arches.

2. In those mild climates which seem to have been the first inhabited parts of this globe, mankind stood more in need of shade from the sun than of shelter from the inclemency of the weather. A very small addition to the shade of the woods served them for a dwelling. Sticks laid across from tree to tree, and covered with brushwood and leaves, formed the first houses in those delightful regions. As population and the arts improved, these huts were gradually refined into commodious dwellings. The materials were the same, but more artfully put together. At last agriculture led the inhabitants out of the woods into the open country. The connection between the inhabitant and the soil became now more constant and more interesting. The wish to preserve this connection was natural, and fixed establishments followed of course. Durable buildings were more desirable than those temporary and perishable cottages—stone was substituted for timber.

But as these improved habitations were gradual refinements on the primitive hut, traces of its construction remained, even when the choice of more durable materials made it in some measure inconvenient. Thus it happened that while a plain building, intended for accommodation only, consisted of walls, pierced with the necessary doors and windows, an ornamented building had, superadded to these essentials, columns, with the whole apparatus of entablature borrowed from the wooden building, of which they had been essential parts, gradually rendered more suitable to the purposes of accommodation and elegance.

3. This view of ornamental architecture will go far to account for some of the more general differences of national style which may be observed in different parts of the world. The Greeks borrowed many of their arts from their Asiatic neighbours, who had cultivated them long before.

4. The ancient Egyptian architecture seems to be a refinement on the hut built of clay, or unburnt bricks, mixed with straw—everything is massive.

5. The Arabian architecture seems a refinement on the tent. A mosque is like a little camp, consisting of a number of little bell tents, stuck close together round a great one. A caravansery is a court surrounded by a row of such tents, each having its own dome. The Greek church of St Sophia at Constantinople has imitated this in some degree; and the copies from it, which have been multiplied in Russia as the sacred form for a Christian church, have added to the original model of clustered tents in the

strictest manner. We are sometimes disposed to think that the painted glass (a fashion brought from the East) was an imitation of the painted hangings of the Arabs.

6. The Chinese architecture is an evident imitation of a wooden building. Sir George Staunton says, that the singular form of their roofs is a *professed* imitation of the cover of a square tent.

In the stone buildings of the Greeks, the roofs were imitations of the wooden ones; hence the lintels, flying cornices, ceilings in compartments, &c.

7. The pediment of the Greeks seems to have suggested the greatest improvement in the art of building. In erecting their small houses, they could hardly fail to observe occasionally, that when two rafters were laid together from the opposite walls, they would, by leaning on each other, give mutual support, as in Plate XLVIII. fig. 1. Nor is it unlikely that such a situation of stones as is represented in fig. 2 would not unfrequently occur by accident to masons. This could hardly fail of exciting a little attention and reflection. It was a pretty obvious reflection, that the stones A and C, by overhanging, leaned against the intermediate stone B, and gave it some support, and that B cannot get down without thrusting aside A and C, or the piers which support them. This was an approach to the theory of an arch; and if this be combined with the observation of fig. 1, we get the disposition represented in fig. 3, having a perpendicular joint in the middle, and the *principle of the arch* is completed. Observe that this is quite different from the principle of the arrangement in fig. 2. In that figure the stones act as wedges, and one cannot get down without thrusting the rest aside. The same principle obtains in fig. 4, consisting of five arch-stones; but in fig. 3 the stones B and C support each other by their mutual pressure (independent of their own weight), arising from the tendency of each lateral pair to fall outwards from the pier. This is the principle of the arch, and would support the key-stone of fig. 4, although each of its joints were perpendicular, by reason of the great friction arising from the horizontal thrust exerted by the adjoining stones.

This was a most important discovery in the art of building; for now a building of any width may be roofed with stone.

8. We are disposed to give the Greeks the merit of this discovery; for we observe arches in the most ancient buildings of Greece, such as the temple of the sun at Athens, and of Apollo at Didymos—not indeed as roofs to any apartment, nor as parts of the ornamental design, but concealed in the walls, covering drains or other necessary openings; and we have not found any *real* arches in any monuments of ancient Persia or Egypt. Sir John Chardin speaks of numerous and extensive subterranean passages at Tchelminar, built of the most exquisite masonry, the joints so exact, and the stones so beautifully dressed, that they look like one continued piece of polished marble; but he nowhere says that they are arched—a circumstance which we think he would not have omitted: no arched door or window is to be seen. Indeed one of the tombs is said to be arch-roofed, but it is all of one solid rock. No trace of an arch is to be seen in the ruins of ancient Egypt; even a wide room is covered with a single block of stone. In the pyramids, indeed, there are two galleries whose roofs consist of many pieces; but their construction puts it beyond doubt that the builder did not know what an arch was; for it is covered in the manner represented in fig. 5, where every projecting piece is more than balanced behind. Yet there are perfect arches, both circular and pointed, in the pyramidal remains at Djebel-el-Berkel, the ancient Napata, in Meroe, the cradle of Egyptian art. The arched dome, however, seems to have arisen in Etruria, and originated in all probability from the employment of the augurs, whose business it was to observe the flight of birds. Their stations for this purpose were *templa*, so called *a templando*, on the summits of hills. To shelter such a person from the weather, and at the same time allow him a full prospect of the country around him, no building was so proper as a dome set on columns; which accordingly is the figure of a temple in the most ancient monuments of that country. We do not recollect a building of this kind in Greece except that called the *Lanthorn of Demosthenes*, but this is covered by a single stone. In the later monuments and coins of Italy or of Rome we commonly find the Etruscan dome and the Grecian temple combined; and the famous Pantheon was of this form, even in its most ancient state.

9. It does not appear that the arch was considered as a part of the *ornamental* architecture of the Greeks during the time of their independency. It is even doubtful whether it was employed in roofing their temples. In none of the *ancient* buildings where the roof is gone can there be seen any rubbish of the vault or mark of the spring of the arch. It is not unfrequent, however, after the Roman conquests, and may be seen in Athens, Delos, Palmyra, Balbeck, and other places. It is very frequent in the magnificent buildings of Rome; such as the Coliseum, the baths of Diocletian, and the triumphal arches, where its form is evidently made the object of attention. But its chief employment was in bridges and aqueducts; and it is in these works that its immense utility is the most conspicuous: for by this happy contrivance a canal or a road may be carried across any stream, where it would be almost impossible to erect piers sufficiently near to each other for carrying lintels. Arches have been executed 130 feet wide, and their execution demonstrates that they may be made four times as wide.

10. As such stupendous arches are the greatest performances of the masonic art, so they are the most difficult and delicate. When we reflect on the immense quantity of materials thus suspended in the air, and compare this with the small cohesion which the firmest cement can give to a building, we shall be convinced that it is not by the force of the cement that they are kept together; they stand fast only in consequence of the proper balance of all their parts. Therefore, in order to erect them with a well-founded confidence of their durability, this balance should be well understood and judiciously employed. We doubt not but that this was understood in some degree by the engineers of antiquity; but they have left us none of their knowledge. They must have had a great deal of mechanical knowledge before they could erect the magnificent and beautiful buildings whose ruins still enchant the world; but they kept it among themselves. We know that the Dionysiacs of Ionia were a great corporation of architects and engineers, who undertook and even monopolized the building of temples, stadiums, and theatres, precisely as the fraternity of masons in the middle ages monopolized the building of cathedrals and conventual churches. Indeed the Dionysiacs resembled the mystical fraternity now called free-masons in many important particulars. They allowed no strangers to interfere in their employment; they recognised each other by signs and tokens; they professed certain mysterious doctrines, under the tuition and tutelage of Bacchus, to whom they built a magnificent temple at Teos, where they celebrated his mysteries as solemn festivals; and they called all other men profane because not admitted to these mysteries. But their chief mysteries and most important secrets seem to be their mechanical and mathematical sciences, or all that academical knowledge which forms the regular education of a civil engineer.

We know that the temples of the gods and the theatres required an immense apparatus of machinery for the celebration of some of their mysteries; and that the Dionysiacs contracted for those jobs, even at far distant places, where they had not the privilege of building the edifice which was to contain them. This is the most likely way of explaining the very small quantity of mechanical knowledge that is to be met with in the writings of the ancients. Even Vitruvius does not appear to have been of the fraternity, and speaks of the Greek architects in terms of respect next to veneration. The *Collegium Murariorum*, or incorporation of masons at Rome, does not seem to have shared the secrets of the Dionysiacs.

11. The art of building arches has been most assiduously cultivated by the associated builders of the middle ages of the Christian church, both Saracens and Christians, and they seem to have indulged in it with fondness: they multiplied and combined arches without end, placing them in every possible situation.

12. Having studied this branch of the art of building with so much attention, they were able to erect the most magnificent buildings with materials which a Greek or Roman architect could have made little or no use of. There is infinitely more scientific skill displayed in a Gothic cathedral than in all the buildings of Greece and Rome. Indeed these last exhibit very little knowledge of the mutual balance of arches, and are full of gross blunders in this respect; nor could they have resisted the shock of time so long, had they not been almost solid masses of stone, with no more cavity than was indispensably necessary.

13. Anthemius and Isidorus, whom the Emperor Justinian had selected as the most eminent architects of Greece, for building the celebrated church of St Sophia at Constantinople, seem to have known very little of this matter. Anthemius had boasted to Justinian that he would outdo the magnificence of the Roman Pantheon, for he would hang a greater dome than it aloft in the air. Accordingly he attempted to raise it on the heads of four piers, distant from each other about 115 feet, and about the same height. He had probably seen the magnificent vaultings of the temple of Mars the Avenger, and the temple of Peace at Rome, the thrusts of which are withstood by two masses of solid wall, which join the side walls of the temple at right angles, and extend sidewise to a great distance. It was evident that the walls of the temple could not yield to the pressure of the vaulting without pushing these immense buttresses along their foundations. He therefore placed four buttresses to aid his piers. They are almost solid masses of stone, extending at least ninety feet from the piers to the north and to the south, forming as it were the side walls of the cross. They effectually secured them from the thrusts of the two great arches of the nave which support the dome; but there was no such provision against the push of the great north and south arches. Anthemius trusted for this to the half dome which covered the semicircular east end of the church, and occupied the whole eastern arch of the great dome. But when the dome was finished, and had stood a few months, it pushed the two eastern piers with their buttresses from the perpendicular, making them lean to the eastward, and the dome and half dome fell in. Isidorus, who succeeded to the charge on the death of Anthemius, strengthened the piers on the east side by filling up some hollows, and again raised the dome. But things gave way before it was closed; and while they were building in one part, it was falling in in another. The pillars and walls of the eastern semicircular end were much shattered by this time. Isidorus seeing that they could give no resistance to the push which was so evidently directed that way, erected some clumsy buttresses on the east wall of the square which surrounded the whole Greek cross, and was roofed in with it, forming a sort of cloister round the whole. These buttresses, spanning over this cloister, leaned against the piers of the dome, and thus opposed the thrusts of the great north and south arches. The dome was now turned for the third time, and many contrivances were adopted for making it extremely light It was made offensively flat, and, except the ribs, was roofed with pumice stone; but, notwithstanding these precautions, the arches settled so as to alarm the architects, and they made all sure by filling up the whole from top to bottom with arcades in three stories. The lowest arcade was very lofty, supported by four noble marble columns, and thus preserved in some measure the church in the form of a Greek cross. The story above formed a gallery for the women, and had six columns in front, so that they did not bear fair on those below. The third story was a dead wall filling up the arch, and pierced with three rows of small, ill-shaped windows. In this unworkmanlike shape it has stood till now, and is the oldest church in the world; but it is an ugly mis-shapen mass, more resembling an overgrown potter's kiln, surrounded with furnaces pierced and patched, than a magnificent temple. We have been thus particular in our account of it, because this history of the building shows that the ancient architects had acquired no distinct notions of the action of arches. Almost any mason of our time would know, that as the south arch would push the pier to the eastward, while the east arch pushed it to the southward, the buttress which was to withstand these thrusts must not be placed on the south side of the pier, but on the south-east side, or that there must be an eastern as well as a southern buttress.

14. No such blunders are to be seen in a Gothic cathedral. Some of them appear, to a careless spectator, to be very massive and clumsy; but when judiciously examined, they will be found very bold and light, being pierced in every direction by arcades; and the walls are divided into cells like a honeycomb, so that they are very stiff, while they are very light.

Dr Hooke's principle of arches

15. About the middle, or rather towards the end, of last century, when the Newtonian mathematics opened the road to true mechanical science, the construction of arches engrossed the attention of the first mathematicians. The first hint of a principle that we have met with is Dr Hooke's assertion, that the figure into which a chain or rope, perfectly flexible, will arrange itself when suspended from two hooks, is, when inverted, the proper form for an arch composed of stones of uniform weight. This he affirmed on the principle, that the figure which a flexible festoon of heavy bodies assumes, when suspended from two points, is, when inverted, the proper form of an arch of the same bodies, touching each other in the same points; because the force with which they mutually press on each other in this last case are equal and opposite to the forces with which they pull at each other in the case of suspension.

This principle is strictly just, and may be extended to every case which can be proposed. We recollect seeing it proposed in very general terms in 1759, when plans were forming for Blackfriars Bridge in London; and since it is perhaps equal in practical utility to the most elaborate investigations of the mathematicians, our readers will not be displeased with a more particular account of it in this place.

explained

16. Let ABC (fig. 6) be a parcel of magnets of any size and shape, and let us suppose that they adhere with great force by any points of contact. They will compose such a flexible festoon as we have been speaking of if

suspended from the points A and C. If this figure be inverted, preserving the same points of contact, they will remain in equilibrio. It will indeed be that kind of equilibrium which will admit of no disturbance, and which may be called a *tottering equilibrium*. If the form be altered in the smallest degree, by varying the points of contact (which indeed are points in the *figure of equilibration*), the magnets will no more recover their former position than a needle, which we had made to stand on its point, will regain its perpendicular position after it has been disturbed.

But if we suppose planes *d e*, *f g*, *h i*, &c. drawn through the points of mutual contact *a*, *b*, *c*, each bisecting the angle formed by the lines that unite the adjoining contacts (*f g*, for example, bisecting the angle formed by *a b*, *b c*), and if we suppose that the pieces are changed for others of the same weights, but having flat sides, which meet in the planes *d e*, *f g*, *h i*, &c., it is evident that we shall have an arch of equilibration, and that the arch will have some stability, or will bear a little change of form without tumbling down: for it is plain that the equilibrium of the original festoon obtained only in the points *a*, *b*, *c*, of contact, where the pressures were perpendicular to the touching surfaces; therefore, if the curve *a*, *b*, *c*, still passes through the touching surfaces perpendicularly, the conditions that are required for equilibrium still obtain. The case is quite similar to that of the stability of a body resting on a horizontal plane. If the perpendicular through the centre of gravity falls within the base of the body, it will not only stand, but it will require some force to push it over. In the original festoon, if a small weight be added in any part, it will change the form of the curve of equilibration a little, by changing the points of mutual contact. This new curve will gradually separate from the former curve as it recedes from A or C. In like manner, when the festoon is set up as an arch, if a small weight be laid on any part of it, it will bring the whole to the ground, because the shifting of the points of contact will be just the contrary to what it should be to suit the new curve of equilibration; but if the same weight be laid on the same part of the arch now constructed with flat joints, it will be sustained if the new curve of equilibration still passes through the touching surfaces.

17. These conclusions, which are very obviously deducible from the principle of the festoon, show us, without any further discussion, that the longer the joints are, the greater will be the stability of the arch, or that it will require a greater force to break it down. Therefore it is of the greatest importance to have the arch-stones as long as economy will permit; and this was the great use of the ribs and other apparent ornaments in the Gothic architecture. The great projections of those ribs augmented their stiffness, and enabled them to support the unadorned compartments of the roof, composed of very small stones, seldom above six inches thick. Many old bridges are still remaining, which are strengthened in the same way by ribs.

Having thus explained, in a very familiar manner, the stability of an arch, we proceed to give the same popular account of the general application of the principle.

and applied.

18. Suppose it be required to ascertain the form of an arch which shall have the span AB (fig. 7), and the height F 8, and which shall have a road-way of the dimensions CDE above it. Let the figure ACDEB be inverted, so as to form a figure A *c d e* B. Let a chain of uniform thickness be suspended from the points A and B, and let it be of such a length that its lower point will hang at, or rather a little below, *f*, corresponding to F. Divide AB into a number of equal parts, in the points 1, 2, 3, &c. and draw vertical lines, cutting the chain in the corresponding points 1, 2, 3, &c. Now take pieces of another chain, and hang them on at the points 1, 2, 3, &c. of the chain A *f* B. This will alter the form of the curve. Cut or trim these pieces of chain, till their lower ends all coincide with the inverted road-way *c d e*. The greater lengths that are hung on in the vicinity of A and B will pull down these points of the chain, and cause the middle point *f* (which is less loaded) to rise a little, and will bring it near to its proper height.

It is plain that this process will produce an arch of perfect equilibration; but some further considerations are necessary for making it exactly suit our purpose. It is an arch of equilibration for a bridge that is so loaded that the weight of the arch-stones is to the weight of the matter with which the haunches and crown are loaded, as the weight of the chain A *f* B is to the sum of the weights of all the little bits of chain very nearly. But this proportion is not known beforehand; we must therefore proceed in the following manner:—Adapt to the curve produced in this way a thickness of the arch-stones as great as are thought sufficient to insure stability; then compute the weight of the arch-stones, and the weight of the gravel or rubbish with which the haunches are to be filled up to the road-way. If the proportion of these two weights be the same with the proportion of the weights of chain, we may rest satisfied with the curve now found; but if different, we can easily calculate how much must be added equally to or taken from each appended bit of chain, in order to make the two proportions equal. Having altered the appended pieces accordingly, we shall get a new curve, which may perhaps require a very small trimming of the bits of chain to make them fit the road-way. This curve will be very near to the curve wanted.

We have practised this method for an arch of 60 feet span and 21 feet high, the arch-stones of which were only two feet nine inches long. It was to be loaded with gravel and shivers. We made a previous computation, on the supposition that the arch was to be nearly elliptical. The distance between the points 1, 2, 3, &c. were adjusted, so as to determine the proportion of the weights of chain agreeable to the supposition. The curve differed considerably from an ellipse, making a considerable angle with the verticals at the spring of the arch. The real proportion of the weights of chain, when all was trimmed so as to suit the road-way, was considerably different from what was expected. It was adjusted. The adjustment made very little change in the curve. It would not have changed it two inches in any part of the real arch. When the process was completed, we constructed the curve mathematically. It did not differ sensibly from this mechanical construction. This was very agreeable information; for it showed us that the first curve, formed by about two hours' labour, on a supposition considerably different from the truth, would have been sufficiently exact for the purpose, being in no place three inches from the accurate curve, and therefore far within the joints of the intended arch-stones. Therefore this process, which any intelligent mason, though ignorant of mathematical science, may go through with little trouble, will give a very proper form for an arch subject to any conditions.

19. The chief defect of the curve found in this way is a want of elegance, because it does not spring at right angles to the horizontal line; but this is the case with all curves of equilibration, as we shall see by and by. It is not material; for, in the very neighbourhood of the piers, we may give it any form we please, because the masonry is solid in that place; nay, we apprehend that a deviation from the curve of equilibration is proper. The construction of that curve supposes that the pressure on every part of the arch is vertical; but gravel, earth, and rub-

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bish, exert somewhat of a hydrostatical pressure laterally in the act of settling, and retain it afterwards. This will require some more curvature at the haunches of an arch to balance it; but what this lateral pressure may be, cannot be deduced with confidence from any experiments that we have seen. We are inclined to think, that if, instead of dividing the horizontal line AB in the points 1, 2, 3, &c. we divide the chain itself into equal parts, the curve will approach nearer to the proper form.

Theory founded on this principle.

20. After this familiar statement of the general principle, it is now time to consider the theory founded on it more in detail. This theory aims at such an adjustment of the position of the arch-stones to the load on every part of the arch, that all shall remain in equilibrio, although the joints be perfectly polished and without any cement. The whole may be reduced to two problems. The first is to determine the vertical pressure or load on every point of a line of a given form, which will put that line in equilibrio. The second is to determine the form of a curve which shall be in equilibrio when loaded in its different points, according to any given law.

The whole theory is deducible from one principle, which will be found fully developed in the article Roof. It is this: when an assemblage of beams or other pieces of solid matter AB, BC, CD, DE, fig. 8, freely movable about its angles as so many joints, is retained in equilibrium by the joint effect of the pressures produced by the weight of its parts, the thrust at any angle, if estimated in a horizontal direction, is the same throughout, and may be represented by any horizontal line BT; and that if a vertical line QS be drawn through T, the thrust exerted at any angle D by the piece CD, in its own direction, will then be represented by BR, drawn parallel to CD; and in like manner, that the thrust in the direction ED is represented by BS, &c.; and, lastly, that the vertical thrust or loads at each angle B, C, D, by which all these other pressures are excited, are represented by the portions QC, CR, RS, of the vertical intercepted by those lines; that is, all these pressures are to the uniform horizontal thrust as the lines which represent them are to BT. The horizontal thrust, therefore, is a very proper unit, with which we may compare all the others. Its magnitude is easily deduced from the same proposition; for QS is the sum of all the vertical pressures of the angles, and therefore represents the weight of the whole assemblage. Therefore as QS is to BT, so is the weight of the whole to the horizontal thrust.

21. To accommodate this theory to the construction of a curvilinear arch vault, let us first suppose the vault to be polygonal, composed of the chords of the elementary arches. Let AVE (fig. 12) be a curvilinear arch, of which V is the vertex, and VX the vertical axis, which we shall consider as the axis or abscissa of the curve, while any horizontal line, such as HK, is an ordinate to the curve. About any point C of the curve, as a centre, describe a circle BLD, cutting the curve in B and D. Draw the equal chords CB, CD. Draw also the horizontal line CF, cutting the circle in F. Describe a circle BCDQ passing through B, C, D. Its centre O will be in a line COQ, which bisects the angle BCD; and C *c*, which touches this circle in C, will bisect the angle *b* C *d*, formed by the equal chords BC, CD. Draw CLP perpendicular to *cb*, and DP perpendicular to CD, meeting CL in P. Through L draw the tangent GLM, meeting CD in G, and the vertical line CM in M. Draw the tangent F *a*, cutting the chords BC, CD, in *b* and *d*, and the tangent to the circle BCDQ in *c*. Lastly, draw *d* N parallel to *bc*.

From what will be demonstrated in the article Roof, it appears that if BC, CD be two pieces of an equilibrated heavy polygon, and if CF represent the horizontal thrust in every angle of the polygon, C *d* and C *b* will severally represent the thrusts exerted by the pieces DC, BC, and that *bd*, or CN, will represent the weight lying on the angle BCD, by which those thrusts are balanced. In the mean time the reader may, without that article, understand the nature of the equilibrium in the following manner. Produce *d* C to *o*, so that C *o* may be equal to C *d*. Draw *bn* to the vertical parallel to *d* C, and join *no*. It is evident that *bno*C is a parallelogram, and that *n* C ($=bd$) = CN. Now the thrust or support of the piece BC is exerted in the direction C *b*, while that of DC is exerted in the direction C *o*. These two thrusts are equivalent to the thrust in the diagonal C *n*; and it is with this compound thrust that the load or vertical pressure CN is in *immediate* equilibrium.

22. Because *b*CL, NCF are right angles, and FCL is common to both, the angles *b*CF and MCL are equal; therefore the right-angled triangles *b*CF and MCL are similar. And since CF is equal to CL, C*b* is equal to CM. It is evident that the triangles GCM and *d*CN are similar. Therefore CG : C*d* = CM : CN = C *b* : C N. Therefore we have $\text{CN} = \frac{\text{C}b \times \text{C}d}{\text{CG}}$. But because CDP and CLG are right angles, and therefore equal, and the angle GCP is common to the two triangles GCL, PCD, and CD is equal to CL, we have CG equal to CP; therefore $\text{CN} = \frac{\text{C}b \times \text{C}d}{\text{CP}}$. Also, since CDP is a right angle, DP meets the diameter in Q, the opposite point of the circumference, and the angle DQC is equal to DC*c* or *c*C*b* (because *b*C*d* is bisected by the tangent), that is, to PCQ (because the right angles *b*CP, *c*CO are equal, and *c*DP is common). Therefore PQ is equal to PC; and if PO be drawn perpendicular to CQ, it will bisect it, and O is the centre of the circle BCDQB.

Now let the points B and D continually approach to C (by diminishing the radius of the small circle), and ultimately coincide with it. It is evident that the circle BCDQ is ultimately the equicurve circle, and that PC ultimately coincides with OC, the radius of curvature. Also C*b*×C*d* becomes ultimately Cc^2. Therefore CN, the vertical load on any point of a curve of equilibration, is $= \frac{\text{C}c^2}{\text{Rad. Curv.}}$.

It is further evident that CF is to C*c* as radius to the secant of the elevation of the tangent above the horizon. Therefore we have the load on any point of the curve always proportional to $\frac{\text{Sec.}^2\text{ Elev.}}{\text{Rad. Curv.}}$.

This load on every elementary arch of the wall is commonly a quantity of solid matter incumbent on that element of the curve, and pressing it vertically; and it may be conceived as made up of a number of heavy lines standing vertically on it. Thus, if the element E*e* of the curve were lying horizontally, a little parallelogram RE*er* standing perpendicularly on it would represent its load. But as this element E*e* has a sloping position, it is plain that, in order to have the same quantity of heavy matter pressing it vertically, the height of the parallelogram must be increased till it meets in *ε*, the line R *ε* drawn parallel to the tangent EG. It is evident that the angle RE*ε* is equal to the angle AEG. Therefore we have ER : E*ε* = Rad. : Sec. Elev.

If therefore the arch is kept in equilibrio by the vertical pressure of a wall, we must have the height of the wall above any point proportional to $\frac{\text{Sec.}^3\text{ Elev.}}{\text{Rad. of Curv.}}$.

Corollaries.

23. *Corol.* 1. If OS be drawn perpendicular to the

vertical CS, CS will be half the vertical chord of the equicurve circle. The angle OCS is equal to cCF, that is, to the angle of elevation. Therefore 1 : Sec. Elev. = CS : CO, and the secant of elevation may be expressed by $\frac{\text{CO}}{\text{CS}}$, and its cube by $\frac{\text{CO}^3}{\text{CS}^3}$. Therefore the height of wall is proportional to $\frac{\text{CO}^3}{\text{CS}^3 \times \text{CO}}$, or to $\frac{\text{CO}^2}{\text{CS}^3}$, or $\frac{\text{CO}^2}{\text{CS}^2 \times \text{CS}}$, or to $\frac{\text{Sec.}^2 \text{ of Elev.}}{\text{Vert. Chord of Curve}}$.

Corol. 2. If we make the arch VC $= z$, the abscissa VH $= x$, the ordinate HC $= y$, the radius osculi CO $= r$, and the $\frac{1}{2}$ vertical chord CS $= s$, the height of wall pressing on any point is proportional to $\frac{dz^3}{rdy^3}$; or to $\frac{dz^2}{sdy^2}$, or $\frac{dx^2 + dy^2}{sdy^2}$. Therefore, when the equation of the curve is given, and the height of wall on any one point of it is also given, we can determine it for any other point; for the equation of the curve will always give us the relation of dz, dx, dy, and the value of r or s. This may be illustrated by an example or two. For this purpose it will generally be most convenient to assume the height above the vertex V for the unit of computation. The thickness of the arch at the crown is commonly determined by other circumstances. At the vertex the tangent to the arch is horizontal, and therefore the cube of the secant is unity or 1. Call the height of wall at the crown H, and let the radius of curvature in that point be R, and its half-chord R (it being then coincident with the radius), and the height on any other point h; we have $\frac{1}{\text{R}} : \frac{dz^3}{rdy^3} = \text{H} : h$, and $h = \text{H} \times \frac{dz^3}{dy^3} \times \frac{\text{R}}{r}$. The other formula gives $h = \text{H} \times \frac{dz^2}{dy^2} \times \frac{\text{R}}{s}$.

Illustrated by examples.

24. *Ex.* 1. Suppose the arch to be a segment of a circle, as in fig. 10, where AE is the diameter, and O the centre. In this arch the curvature is the same throughout, or $\frac{\text{R}}{r} = 1$. Therefore $h = \text{H} \times \frac{dz^3}{dy^3}$, or $= \text{H} \times$ Cube Sec. Elev.

This gives a very simple calculus. To the logarithm of H add thrice the logarithm of the secant of elevation. The sum is the logarithm of h.

It gives also a very simple construction. Draw the vertical CS, cutting the horizontal diameter in S. Draw ST, cutting the radius OC perpendicularly in T. Draw the horizontal line Tz, cutting the vertical in z. Join zO. Make Cu = Vv, and draw ux parallel to zO: Cc must be made = Cx. The demonstration is evident.

It is very easy to see that if CV is an arch of 60°, and Vv is $\frac{1}{14}$th of VO, the points v and c will be on a level; for the secant of CV is twice CO, and therefore Cc is eight times Vv, which is $\frac{1}{7}$th of VH.

The dotted line $vgcf$ is drawn according to this calculus or construction. It falls considerably below the horizontal line in the neighbourhood of c; and then, passing very obliquely through c, it rises rapidly to an immeasurable height, because the vertical line through A is its asymptote. This must evidently be the case with every curve which springs at right angles with a horizontal line.

It is plain that if vV be greater, all the other ordinates of the curve $vgcf$, resting on the circumference AVE, will be greater in the same proportion, and the curve will cut the horizontal line drawn through v in some point nearer to v than c is. Hence it appears that a circular arch cannot be put in equilibrio by building on it up to a horizontal line, whatever be its span, or whatever be the thickness at the crown. We have seen that when this thickness is only $\frac{1}{14}$th of the radius, an arch of 120 degrees will be too much loaded at the flanks. This thickness is much too small for a bridge, being only $\frac{1}{25}$th of the span CM, whereas it should have been almost double of this, to bear the inequalities of weight that may occasionally be on it. When the crown is made still thinner, the outline is still more depressed before it rises again. There is therefore a certain span, with a corresponding thickness at the crown, which will deviate least of all from a horizontal line. This is an arch of about 45 degrees, the thickness at the crown being about one fourth of the span, which is extravagantly great. It appears in general, therefore, that the circle is not a curve suited to the purposes of a bridge or an arcade, which requires an outline nearly horizontal.

Ex. 2. Let the curve be a parabola AVE (fig. 14), of which V is the vertex, and DG the directrix. Draw the diameters DCF, GVN, the tangents CK, VP, and the ordinates VF and CN. It is well known that GV is to DC as VP² to CK², or as CN² to CK². Also 2 GV is the radius of the osculating circle at V, and 2 DC is one half of the vertical chord of the osculating circle at C.

Therefore CN² : CK² (or $dy^2 : dz^2$) = R : s; and $s = \frac{dz^2}{dy^2}$R. But Cc, or $h = \text{H} \times \frac{dz^2\text{R}}{dy^2 s}$. Therefore $h = \text{H} \times \frac{dz^2\text{R}}{dy^2 \frac{dz^2}{dy^2}\text{R}} = \text{H} \times \frac{dz^2\text{R}}{dz^2\text{R}} = \text{H}$. Therefore C$c$ = vV.

It follows from this investigation, that the back or extrados of a parabolic arch of equilibration must be parallel to the arch or soffit itself; or that the thickness of the arch, estimated in a vertical direction, must be equal throughout; or that the extrados is the same parabola with the soffit or intrados.

We have selected these two examples merely for the simplicity and perspicuity of the solutions, which have been effected by means of elementary geometry only, instead of employing the analytical value of the radius of the osculatory circle, viz. $\frac{dz^3}{dyd^2x - dxd^2y}$, which would have involved us at last in the doctrine of second fluxions. We have also preferred simplicity to elegance in the investigation, because we wish to instruct the practical engineer who may not be a proficient in the higher mathematics.

To find the form of an arch when the figure of its back is given.

25. The converse of the problem, namely, to find the form of the arch when the figure of the back of it is given, is the most usual question of the two, at least in cases which are most important and most difficult. Of these, perhaps, bridges are the chief. Here the necessity of a road-way, of easy and regular ascent, confines us to an outline nearly horizontal, to which the curve of the arch must be adapted. This is the most difficult problem of the two; and we doubt whether it can be solved without employing infinite approximating series instead of accurate values.

Let ave (fig. 9) be the intended outline or extrados of the arch AVE, and let v Q be the common axis of both curves. From c and C, the corresponding points, draw the ordinates ch, CH. Let the thickness vV at the top be a, the abscissa vh be $= u$, and VH $= x$, and let the equal ordinates ch, CH, be y, and the arch VC be z.

Arch.

Then, by the general theorem, $cC = \frac{dz^3}{rdy^3}$, r being the radius of curvature. This, by the common rules, is $= \frac{dz^3}{dyd^2x - dxd^2y}$. This gives us $cC \div \frac{dyd^2x - dxd^2y}{dy^3}$, or $= \frac{dyd^2x - dxd^2y}{dy^3} \times C$; where C is a constant quantity, found by taking the real value of cC in V, the vertex of the curve. But it is evident that it is also $= a + x - u$. Therefore $a + x - u = \frac{dyd^2x - dxd^2y}{dy^3} \times C = \frac{C}{dy} \times$ fluxion of $\frac{dx}{dy}$.

If we now substitute the true value of u (which is given because the extrados is supposed to be of a known form), expressed in terms of y, the resulting equation will contain nothing but x and y, with their first and second fluxions, and known quantities. From this equation the relation of x and y must be found by such methods as seem best adapted to the equation of the extrados.

Fortunately the process is more simple and easy in the most common and useful case than we should expect from this general rule; we mean the case where the extrados is a straight line, especially when this is horizontal. In this case u is equal to o.

Pl. XLIX. Fig. 6. *Ex.* To find the form of the balanced arch AVE, having the horizontal line cv for its extrados.

Keeping the same notation, we have $u = o$, and therefore

$$a + x = \frac{C}{dy} \times \text{fluxion of } \frac{dx}{dy}.$$

Assume $dy = \frac{dx}{v}$; then $\frac{dx}{dy} = v$, and $\frac{C}{dy} \times$ fluxion of $\frac{dx}{dy} = \frac{Cvdv}{dx}$, that is, $a + x = \frac{Cvdv}{dx}$. Therefore $adx + xdx = Cvdv$; and by taking the fluents, we have $2\,ax + x^2 = Cv^2$; and $v = \sqrt{\frac{2\,ax + x^2}{C}}$. Consequently, $dy = \frac{\sqrt{C}dx}{\sqrt{2\,ax + x^2}}$ $\left(\text{being} = \frac{dx}{v}\right)$. Taking the fluent of this, we have $y = \sqrt{C} \times L\,(2\,a + 2\,x + 2\sqrt{2\,ax + x^2})$. But at the vertex, where $x = o$, we have $y = \sqrt{C} \times L\,(2\,a)$. The corrected fluent is therefore $y = \sqrt{C} \times L\frac{a + x + \sqrt{2\,a\,x + x^2}}{a}$.

It only remains to find the constant quantity C. This we readily obtain by selecting some point of the extrados where the values of x and y are given by particular circumstances of the case. Thus, when the span 2 s and height h of the arch are given, we have

$s = \sqrt{C} \times L\left(\frac{a + h + \sqrt{2\,a\,h + h^2}}{a}\right)$, and consequently $\sqrt{C} = \frac{s}{L\left(\frac{a + h + \sqrt{2\,a\,h + h^2}}{a}\right)}$. Therefore

$$\text{the general value of } y = s \times \frac{L\left(\frac{a + x + \sqrt{2\,a\,x + x^2}}{a}\right)}{L\left(\frac{a + h + \sqrt{2\,a\,h + h^2}}{a}\right)}$$

$$= \frac{s}{L\frac{a + h + \sqrt{(2ah + h^2)}}{a}} \times L\frac{a + x + \sqrt{2\,a\,x + a^2}}{a}.$$

26. As an example of the use of this formula, we subjoin a table calculated by Dr Hutton of Woolwich, for an arch, the span of which is 100 feet, and the height 40, which are nearly the dimensions of the middle arch of Blackfriars Bridge in London.

y	x	y	x	y	x
0	6,000	21	10,381	36	21,774
2	6,035	22	10,858	37	22,948
4	6,144	23	11,368	38	24,190
6	6,324	24	11,911	39	25,505
8	6,580	25	12,489	40	26,894
10	6,914	26	13,106	41	28,364
12	7,330	27	13,761	42	29,919
13	7,571	28	14,457	43	31,563
14	7,834	29	15,196	44	33,299
15	8,120	30	15,980	45	35,135
16	8,430	31	16,811	46	37,075
17	8,766	32	17,693	47	39,126
18	9,168	33	18,627	48	41,293
19	9,517	34	19,617	49	43,581
20	9,934	35	20,665	50	46,000

The figure for this proposition is exactly drawn according to these dimensions, that the reader may judge of it as an object of sight. It is by no means deficient in gracefulness, and is abundantly roomy for the passage of craft; so that no objection can be offered against its being adapted on account of its mechanical excellency.

Defects of the Catenarean curve.

The reader will perhaps be surprised that we have made no mention of the celebrated Catenarean curve, which is commonly said to be the best form for an arch; but a little reflection will convince him, that although it is the only form for an arch consisting of stones of equal weight, and touching each other only in single points, it cannot suit an arch which must be filled up in the haunches, in order to form a road-way. He will be more surprised to hear, after this, that there is a certain thickness at the crown, which will put the Catenarea in equilibrio, even with a horizontal road-way; but this thickness is so great as to make it unfit for a bridge, being such that the pressure at the vertex is equal to the horizontal thrust. This would have been about 37 feet in the middle arch of Blackfriars Bridge. The only situation, therefore, in which the Catenarean form would be proper, is an arcade carrying a height of dead wall; but in this situation it would be very ungraceful. Without troubling the reader with the investigation, it is sufficient to inform him, that in a Catenarean arch of equilibration the abscissa VH is to the abscissa $v\,h$ in the constant ratio of the horizontal thrust to its excess above the pressure on the vertex

27. Thus much will serve, we hope, to give the reader a clear notion of this celebrated theory of the equilibrium of arches, one of the most delicate and important applications of mathematical science. Volumes have been written on the subject, and it still occupies the attention of mechanicians. But we beg leave to say, with great deference to the eminent persons who have prosecuted this theory, that their speculations have been of little service, and are little attended to by the practitioner. Nay, we may add, that Sir Christopher Wren, perhaps the most accomplished architect that Europe has seen, seems to have thought it of little value; for, among the fragments which have been preserved of his studies, there are to be seen some imperfect dissertations on this very subject, in which he takes no notice of this theory, and considers the balance of arches in quite another way. These are collected by the author of the account of Sir Christopher Wren's family. This man's great sagacity,

and his great experience in building, and still more his experience in the repairs of old and crazy fabrics, had shown him many things very inconsistent with this theory, which appears so specious and safe. The general facts which occur in the failure of old arches are highly instructive, and deserve the most careful attention of the engineer; for it is in this state that their defects, and the process of nature in their destruction, are most distinctly seen. We venture to affirm, that a very great majority of these facts are irreconcilable to the theory. The way in which circular arches commonly fail, is by the sinking of the crown and the rising of the flanks. It will be found by calculation, that in most of the cases it ought to have been just the contrary. But the clearest proof is, that arches very rarely fail where their load differs most remarkably from that which this theory allows. Semicircular arches have stood the power of ages, as may be seen in the bridges of ancient Rome, and in the numerous arcades which the ancient inhabitants have erected. Now, all arches which spring perpendicularly from the horizontal line require, by this theory, a load of infinite height; and even to a considerable distance from the springing of the arch, the load necessary for the theoretical equilibrium is many times greater than what is ever laid on those parts; yet a failure in the immediate neighbourhood of the spring of an arch is a most rare phenomenon, if it ever was observed. Here is a most remarkable deviation from the theory; for, as is already observed, the load is frequently not the fourth part of what the theory requires.

28. Many other facts might be adduced which show great deviation from the legitimate results of the theory. We hope to be excused, therefore, by the mathematicians for doubting of the justness of this theory. We do not think it erroneous, but defective, leaving out circumstances which we apprehend to be of great importance; and we imagine that the defects of the theory have arisen from the very anxiety of the mechanicians to make it perfect. The arch-stones are supposed to be perfectly smooth or polished, and not to be connected by any cement, and therefore to sustain each other merely by the equilibrium of their vertical pressure. The theory insures this equilibrium, and this only, leaving unnoticed any other causes of mutual action.

The authors who have written on the subject say expressly that an arch which thus sustains itself must be stronger than another which would not; because when, in imagination, we suppose both to acquire connection by cement, the first preserves the influence of this connection unimpaired; whereas in the other, part of the cohesion is wasted in counteracting the tendency of some parts to break off from the rest by their want of equilibrium. This is a very specious argument, and would be just, if the forces which are mutually exerted between the parts of the arch in its settled state were merely vertical pressures, or, where different, were inconsiderable in comparison with those which are really attended to in the construction.

But this is by no means the case. The forms which the uses for which arches are erected oblige us to adopt, and the loads laid on the different points of the arch, frequently deviate considerably from what are necessary for the equilibrium of vertical pressures. The varying load on a bridge, when a great waggon passes along it, sometimes bears a very sensible proportion to the weight of that point of the arch on which it rests. It is even very doubtful whether the pressures which are occasioned by the weight of the stuff employed for filling up the flanks really act in a vertical direction, and in the proportion which is supposed. We are pretty certain that this is not the case with sand, gravel, fat mould, and many substances in very general use for this purpose. When this is the case, the pressures sustained by the different parts of the arch are often very inconsistent with the theory; a part of the arch is overloaded and tends to fall in, but is prevented by the cement. This part of the arch, therefore, acts on the remoter parts by the intervention of the parts between, employing those intermediate parts as a kind of levers to break the arch in a remote part, just as a lintel would be broken. We apprehend that a mathematician would be puzzled how to explain the stability of an arch cut out of a solid and uniform mass of rock. His theory considers the mutual thrusts of the arch-stones as in the direction of the tangents to the arch. Why so? Because he supposes that all his polished joints are perpendicular to those tangents. But in the present case he has no existing joints; and there seems to be nothing to direct his imagination in the assumption of joints, which, however, are absolutely necessary for employing his theory, because, without a supposition of this kind, there seems no conceiving any mutual abutment of the arch-stones. Ask a common but intelligent mason, what notion he forms of such an arch? We apprehend that he will consider it as no arch, but as a lintel, which may be broken like a wooden lintel, and which resists entirely by its cohesion. He will not readily conceive that, by cutting the under side of a stone lintel into an arched form, and thus taking away more than half of its substance, he has changed its nature of a lintel, or given it any additional strength. Nor would there be any change made in the way in which such a mass of stone would resist being broken down, if nothing were done but forming the under side into an arch. If the lintel be so laid on the piers that it can be broken without its parts pushing the piers aside (which will be the case if it lies on the piers with horizontal joints), it will break like any other lintel; but if the joints are directed downwards, and converging to a point within the arch, the broken stone (suppose it broken at the crown by an overload in that part) cannot be pressed down without forcing the piers outwards. Now, in this mode of acting, the mind cannot trace any thing of the statical equilibrium that we have proceeded on in the foregoing theory. The two parts of the broken lintel seem to push the piers aside in the same manner that two rafters push outwards the walls of a house when their feet are not held together by a tie-beam. If the piers cannot be pushed aside (as when the arch abuts on two solid rocks), nothing can press down the crown which does not crush the stone.

This conclusion will be strictly true if the arch is of such a form that a straight line drawn from the crown to the pier lies wholly within the solid masonry. Thus, if the vault consist of two straight stones, as in Plate XLVIII. fig. 1, or if it consist of several stones, as in Plate XLIX. fig. 7, disposed in two straight lines, no weight laid on the crown can destroy it in any other way than by crushing it to powder.

29. But when straight lines cannot be drawn from the overloaded part to the firm abutments through the solid masonry, and when the cohesion of the parts is not able to withstand the transverse strains, we must call the principles of equilibrium to our aid; and, in order to employ them with safety, we must consider how they are modified by the excitement of the cohering forces.

The cohesion of the stones with each other by cement or otherwise has in almost every situation a bad effect. It enables an overload at the crown to break the arch near the haunches, causing those parts to rise, and then to spread outwards, just as a Mansarde or Kirb roof would do if the truss-beam which connects the heads of the lower rafters were sawn through. This can be prevented

Arch. only by loading that part more than is requisite for equilibrium. It would be prudent to do this to a certain degree, because it is by this cohesion that the crown always becomes the weakest part of the arch, and suffers more by any occasional load.

We expect that it will be said in answer to all this, that the cohesion given by the strongest cement that we can employ, nay the cohesion of the stone itself, is a mere nothing in comparison with the enormous thrusts that are in a state of continual exertion in the different parts of an arch. This is very true; but there is another force which produces the same effect, and which increases nearly in the proportion that those thrusts increase, because it arises from them. This is the friction of the stones on each other. In dry freestone this friction considerably exceeds one half of the mutual pressure. The reflecting reader will see that this produces the same effect, in the case under consideration, that cohesion would do; for while the arch is in the act of failing, the mutual pressure of the arch-stones is acting with full force, and thus produces a friction more than adequate to all the effects we have been speaking of.

Process of the breaking of an arch.

30. When these circumstances are considered, we imagine that it will appear that an arch, when exposed to a great overload on the crown (or indeed on any part), divides of itself into a number of parts, each of which contains as many arch-stones as can be pierced (so to speak) by one straight line, and that it may then be considered as nearly in the same situation with a polygonal arch of long stones abutting on each other like so many beams in a Norman roof, but without their braces and ties. It tends to break at all those angles; and it is not sufficiently resisted there, because the materials with which the flanks are filled up have so little cohesion, that the angle feels no load except what is immediately above it; whereas it should be immediately loaded with all the weight which is diffused over the adjoining side of the polygon. This will be the case, even though the curvilinear arch be perfectly equilibrated. We recollect some circumstances in the failure of a considerable arch, which may be worth mentioning. It had been built of an exceedingly soft and friable stone, and the arch-stones were too short. About a fortnight before it fell, chips were observed to be dropping off from the joints of the arch-stones, about ten feet on each side of the middle, and also from another place on one side of the arch, about twenty feet from its middle. The masons in the neighbourhood prognosticated its speedy downfall, and said that it would separate in those places where the chips were breaking off. At length it fell; but it first split in the middle, and about fifteen or sixteen feet on each side, and also at the very springing of the arch. Immediately before the fall a shivering or crackling noise was heard, and a great many chips dropped down from the middle, between the two places from whence they had dropped a fortnight before. The joints opened above at those new places above two inches, and in the middle of the arch the joints opened below, and in about five minutes after this the whole came down. Even this movement was plainly distinguishable into two parts. The crown sunk a little, and the haunches rose very sensibly, and in this state it hung for about half a minute. The arch-stones of the crown were hanging by their upper corners: when these splintered off, the whole fell down.

We apprehend that the procedure of nature was somewhat in this manner. Straight lines can be drawn within the arch-stones from A (Plate XLIX. fig. 8) to B and D, and from these points to C and E. Each of the portions ED, DA, AB, BC, resist as if they were of one stone, composing a polygonal vault EDABC. When this is overloaded at A, A can descend in no other way than by pushing the angles B and D outwards, causing the portions BC, DE, to turn round C and E. This motion must raise the points B and D, and cause the arch-stones to press on each other at their *inner* joints *b* and *d*. This produced the copious splintering at those joints immediately preceding the total downfall. The splintering which happened a fortnight before arose from this circumstance, that the lines AB and AD, along which the pressure of the overload was propagated, were tangents to the soffit of the arch in the points F, H, and G, and therefore the strain lay all on those corners of the arch-stones, and splintered a little from off them till the whole took a firmer bed. The subsequent phenomena are evident consequences of this distribution and modification of pressure, and can hardly be explained in any other way, at least not on the theoretical principles already set forth; for in this bridge the loads at B and D were very considerably greater than what the equilibrium required; and we think that the first observed splintering at H, F, and G, was most instructive, showing that there was an extraordinary pressure at the inner joints in those places, which cannot be explained by the usual theory.

Not satisfied with this single observation after this way of explaining it occurred to us, and not being able to find any similar fact on record, the writer of this article got some small models of arches executed in chalk, and subjected them to many trials, in hopes of collecting some general laws of the internal workings of arches which finally produce their downfall. He had the pleasure of observing the above-mentioned circumstances take place very regularly and uniformly when he overloaded the models at A. The arch always broke at some place B considerably beyond another point F, where the first chipping had been observed. This is a method of trial that deserves the attention both of the speculatist and the practitioner.

If these reflections are any thing like a just account of the procedure of nature in the failure of an arch, it is evident that the ingenious mathematical theory of equilibrated arches is of little value to the engineer. We ventured to say as much already, and we rested a good deal on the authority of Sir Christopher Wren. He was a good mathematician, and delighted in the application of this science to the arts. He was a celebrated architect, and his reports on the various works committed to his charge show that he was in the continued habit of making this application. Several specimens remain of his own methods of applying them. The roof of the theatre of Oxford, the roof of the cupola of St Paul's, and in particular the mould on which he turned the inner dome of that cathedral, are proofs of his having studied this theory most attentively. He flourished at the very time that it occupied the attention of the greatest mechanicians of Europe; but there is nothing to be found among his papers which shows that he had paid much regard to it. On the contrary, when he has occasion to deliver his opinion for the instruction of others, and to explain to the dean and chapter of Westminster his operations in repairing that collegiate church, this great architect considers an arch just as a sensible and sagacious mason would do, and very much in the way that we have just now been treating it. (See *Account of the Family of Wren*, p. 356.) Supported therefore by such authority, we would recommend this way of considering an arch to the study of the mathematician; and we would desire the experienced mason to think of the most efficacious methods for resisting this tendency of arches to rise in the flanks. Unfortunately there seems to be no precise principle to point out the place where this tendency is most remarkable.

31. We are therefore highly pleased with the ingenious

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contrivance of Mr Mylne, the architect of Blackfriars Bridge in London, by which he determines this point with precision, by making it impossible for the overloaded arch to spring in any other place. Having thus confined the failure to a particular spot, he with equal art opposes a resistance which he believes to be sufficient; and the present condition of that noble bridge, which does not in any place show the smallest change of shape, proves that he was not mistaken. Looking on this work as the first, or at least the second, specimen of masonic ingenuity that is to be seen in the world, we imagine that our readers will be pleased with a particular account of its most remarkable circumstances.

Construction of Blackfriars Bridge. Pl. XLIX.

The span *k a* (fig. 1) of the middle arch is 100 feet, and its height OV is 40, and the thickness KV of the crown is six feet seven inches. Its form is nearly elliptical; the part AVZ being an arch of a circle whose centre is C, and radius 56 feet, and the two lateral portions A *k* B and Z *a* E being arches described with a radius of 35 feet nearly. The thickness of the pier at *a b* is 19 feet. The thickness of the arch increases from the crown V to Y, where it is eight or nine feet. All the arch-stones have their joints directed to the centres of their curvature. The joints are all joggled, having a cubic foot of hard stone let half-way into each. By this contrivance the joints cannot slide, nor can any weight laid on the crown ever break the arch in that part if the piers do not yield; for a straight line from the middle of KV to the middle of the joint YI is contained within the solid masonry, and does not even come near the inner joints of the arch-stones; therefore the whole resists like one stone, and can be only broken by crushing it. The joint at Z is very nearly perpendicular to a line ZF drawn to the outer edge of the foundation of the pier. By this it was intended to take off all tendency of the pressure on the joint *d* Z to overset the pier; for if we suppose, according to the theory of equilibration, that this pressure is necessarily exerted perpendicularly to the joint, its direction passes through the fulcrum at F, round which it is thought that the pier must turn in the act of oversetting. This precaution was adopted in order to make the arch quite independent of the adjoining arches; so that although any of them should fall, this arch should run no risk.

Still farther to secure the independence of the arch, the following construction was practised to unite it into one mass, which should rise all together. All below the line *a b* is built of large blocks of Portland stone, dovetailed with sound oak. Four places in each course are interrupted by equal blocks of a hard stone called *Kentish rag*, sunk half-way in each course. These act as joggles, breaking the courses, and preventing them from sliding laterally.

The portion *a* Y of the arch is joggled like the upper part. The interior part is filled up with large blocks of Kentish rag, forming a kind of coursed rubble-work, the courses tending to the centres of the arch. The under corner of each arch-stone projects over the one below it. By this form it takes fast hold of the rubble-work behind it. Above this rubble there is constructed the inverted arch I *e* G of Portland stone.[1] This arch shares the pressure of the two adjoining arches, along with the arch-stones in Y *a* and in G *b*. Thus all tend together to compress and keep down the rubble-work in the heart of this part of the pier. This is a very useful precaution; for it often happens, that when the centres of the arches are struck before the piers are built up to their intended heights, the thrust of the arches squeezes the rubble-work horizontally, after the mortar has set, but before it has dried and acquired its utmost hardness. Its bond is broken by this motion, and it is squeezed up, and never acquires its former firmness. This is effectually prevented by the pressure exerted by the back of the inverted arch.

Above this counter-arch is another mass of coursed rubble, and all is covered by a horizontal course of large blocks of Portland stone, abutting against the back of the arch-stone ZI and its corresponding one in the adjoining arch. This course connects the feet of the two arches, preserves the rubble-work from too great compression, and protects it from soaking water. This last circumstance is important; for if the water which falls on the road-way is not carried off in pipes, it soaks through the gravel or other rubbish, rests on the mortar, and keeps it continually wet and soft. It cannot escape through the joints of good masonry, and therefore fills up this part like a funnel.

Supposing the adjoining arch fallen, and all tumbled off that is not withheld by its situation, there will still remain in the pier a mass of about 3500 tons. The weight of the portion VY is about 2000 tons. The directions of the thrusts VY and YF are such, that it would require a load of 4500 tons on VY to overturn the pier round F. This exceeds VY by 2500 tons—a weight incomparably greater than any that can ever be laid on it.

Such is the ingenious construction of Mr Mylne. It evidently proceeds on the principles recommended above—principles which had occurred to his experience and sagacious mind during the course of his extensive practice. We have seen attempts by other engineers to withstand the horizontal thrusts of the arch by means of counter-arches inserted in the same manner as here, but extending much farther over the main arch; but they did not appear to be well calculated for producing this effect. A counter-arch springing from any point between Y and V has no tendency to hinder that point from rising by the sinking of the crown; and such a counter-arch will not resist the precisely horizontal thrust so well as the straight course of Mr Mylne.

Origin of the Gothic arches.

32. The great incorporation of architects who built the cathedrals of Europe departed entirely from the styles of ancient Greece and Rome, and introduced another, in which arcades made the principal part. Not finding in every place quarries from which blocks could be raised in abundance of sufficient size for forming the far-projecting cornices of the Greek orders, they relinquished those proportions, and adopted a style of ornament which required no such projections; and having substituted arches for the horizontal architrave or lintel, they were now able to erect buildings of vast extent with spacious openings, and all this with very small pieces of stone. The form which had been adopted for a Christian temple occasioned many intersections of vaultings, and multiplied the arches exceedingly. Constant practice gave opportunities of giving every possible variety of these intersections, and taught the art of balancing arch against arch in every variety of situation. An art so multifarious, and so much out of the road of ordinary thought, could not but become an object of fond study to the architects most eminent for ingenuity and invention. Becoming thus the dupes of

[1] We know from good authority that the counter-arch here spoken of, although originally intended, was never executed, because it was not thought necessary. The notion was, however, excellent, and it has, we believe, been actually executed in the Strand Bridge. We rather think the joggling was also abandoned, and, as far as we can judge, was not likely to be of any use.

their own ingenuity, they were fond of displaying it even when not necessary. At last arches became their principal ornament, and a wall or ceiling was not thought dressed out as it should be till filled full of mock arches, crossing and abutting on each other in every direction. In this process in their ceilings they found that the projecting mouldings, which we now call the Gothic tracery, formed the chief supports of the roofs. The plane surfaces included between those ribs were commonly vaulted with very small stones, seldom exceeding six or eight inches in thickness. This tracery, therefore, was not a random ornament. Every rib had a position and direction that was not only proper, but even necessary. Habituated to this scientific arrangement of the mouldings, they did not deviate from it when they ornamented a smooth surface with mock arches; and in none of the highly ornamented *ancient* buildings will we find any false positions.

33. This is by no means the case in many of the modern imitations of Gothic architecture, even by our best architects. Ignorant of the directing principle, or not attending to it, in their stucco-work they please the unskilled eye with pretty radiated figures; but in these we frequently see such abutments of mouldings as would infallibly break the arches, if these mouldings were really performing their ancient office, and supporting a vaulting of considerable extent. Nay, this began even before the Gothic style was finally abandoned. Several instances are to be found in the highly enriched vaultings of New College and Christ Church in Oxford, in St George's Chapel at Windsor, and Henry VII.'s Chapel in Westminster.

We call the middle ages rude and barbarous; but there was surely much knowledge in those who could execute such magnificent and difficult works. The working drafts which were necessary for such varieties of oblique intersections must have required considerable skill, and would at present occupy many very expensive volumes of *Masons' Jewels*, *Carpenters' Manuals*, and the like. All this knowledge was kept a profound secret by the corporation, and on its breaking up we had all to learn again.

34. There is no appearance, however, that those architects had studied the theory of equilibrated arches. They had adopted an arch which was very strong, and permitted considerable irregularities of pressure—we mean the pointed arch. The very deep mouldings with which it was ornamented made the arch-stones very long in proportion to the span of the arch. But they had studied the mutual thrust of arches on each other with great care; and they contrived to make every invention for this purpose become an ornament, so that the eye *required* it as a necessary part of the building. Thus we frequently see small buildings having buttresses at the sides. These are necessary in a large vaulted building, for withstanding the outward thrust of the vaulting; but they are useless when we have a flat ceiling within. Pinnacles on the heads of the buttresses are now considered as ornaments, but originally they were put there to increase the weight of the buttress: even the great tower in the centre of a cathedral, which now constitutes its greatest ornament, is a load almost indispensably necessary, for enabling the four principal columns to withstand the combined thrust of the aisles, of the nave, and transepts. In short, the more closely we examine the ornaments of this architecture, the more shall we perceive that they are essential parts, or derived from them by imitation; and the more we consider the whole style of it, the more clearly do we see that it is all deduced from the relish for arcades, indulged in the extreme, and pushed to the limit of possibility of execution.

Dome or Cupola.

35. There is another species of arch which must not be overlooked, namely, the DOME or CUPOLA, with all its varieties, which include even the pyramidal steeple or spire.

It is evident that the erection of a dome is also a scientific art, proceeding on the principles of equilibration, and that these principles admit and require the same or similar modifications, in consequence of the cohesion and friction of the materials. At first sight, too, a dome appears a more difficult piece of work than a plain arch; but when we observe potters' kilns, and glasshouse domes, and cones of vast extent, erected by ordinary bricklayers, and with materials vastly inferior in size to what can be employed in common arches of equal extent, we must conclude that the circumstance of curvature in the horizontal direction, or the abutment of a circular base, gives some assistance to the artist. Of this we have complete demonstration in the case of the cone. We know that a vaulting in the form of a pent roof could not be executed to any considerable extent, and would be extremely hazardous, even in the smallest dimensions; while a cone of the greatest magnitude can be raised with very small stones, provided only that we prevent the bottom from flying out, by a hoop, or any similar contrivance.

36. When we think a little of the matter, we see plainly, that if the horizontal section be perfectly round, and the joints be all directed to the axis, they all equally endeavour to slide inwards, while no reason can be offered why any individual stone should prevail. They are all wedges, and operate only as wedges. When we consider any single course, therefore, we see that it cannot fall in, even though it may be part of a curve which cannot stand as a common arch; nay, we see that a dome may be constructed having the convexity of the curve, by the revolution of which it is formed, turned towards the axis, so that the outline is concave. We shall afterwards find that this is a stronger dome by far than if the convexity were outwards, as in a common arch. We see also that a cone may be loaded on the top with the greatest weight, without the smallest danger of forcing it down, so long as the bottom course is firmly kept from bursting outwards. The stone lanthorn on the top of St Paul's cathedral in London weighs several hundred tons, and is carried by a brick cone of 18 inches thick, with perfect safety, as long as the bottom course is prevented from bursting outwards. The reason is evident: The pressure on the top is propagated along the cone in the direction of the slant side; and, so far from having any tendency to break it in any part, it tends rather to prevent its being broken by any irregular pressure from foreign causes.

Proper construction of octagonal pyramids.

37. For the same reasons the octagonal pyramids, which form the spires of Gothic architecture, are abundantly firm, although very thin. The sides of the spire of Salisbury cathedral are not eight inches thick after the octagon is fully formed. It is proper, however, to direct the joints to the axis of the pyramid, and to make the coursing joints perpendicular to the slant side, because the projecting mouldings which run along the angles are the abutments on which the whole panel depends. A considerable art is necessary for supporting those panels or sides of the octagon which spring from the angles of the square tower. This is done by beginning a very narrow pointed arch on the square tower at a great distance below the top; so that the legs of the arch being very long, a straight line may be drawn from the top of the keystone of the arch through the whole arch-stones of the legs. By this disposition the thrusts arising from the weight of these four panels are made to meet on the massive masonry in the middle of the sides of the tower, at a great

distance below the springing of the spire. This part, being loaded with the great mass of perpendicular wall, is fully able to withstand the horizontal thrust from the legs of those arches. In many spires these thrusts are still farther resisted by iron bars which cross the tower, and are hooked into pieces of brass firmly bedded in the masonry of the sides.

38. There is much nice balancing of this kind to be observed in the highly ornamented open spires; such as those of Brussels, Mecklin, Antwerp, &c. We have not many of this sort in Britain. In those of great magnitude, the judicious eye will discover, that parts, which a common spectator would consider as mere ornaments, are necessary for completing the balance of the whole. Tall pinnacles, nay even pillars carrying entablatures and pinnacles, are to be seen standing on the middle of the slender leg of an arch. On examination we find that this is necessary, to prevent the arch from springing upwards in that place by the pressure at the crown. The steeple of the cathedral of Mecklin was the most elaborate piece of architecture in this taste in the world, and was really a wonder; but it was not calculated to withstand a bombardment, which destroyed it in 1578.

Such frequent examples of irregular and whimsical buildings of this kind show that great liberties may be taken with the principle of equilibration without risk, if we take care to secure the base from being thrust outwards. This may always be done by hoops, which can be concealed in the masonry; whereas in common arches these ties would be visible, and would offend the eye.

39. It is now time to attend to the principle of equilibrium as it operates in a simple circular dome, and to determine the thickness of the vaulting when the curve is given, or the curve when the thickness is given. Therefore, let B b A (Plate XLIX. fig. 2) be the curve which produces the dome by revolving round the vertical axis AD. We shall suppose this curve to be drawn through the middle of all the arch-stones, and that the coursing or horizontal joints are everywhere perpendicular to the curve. We shall suppose (as is always the case) that the thickness KL, HI, &c. of the arch-stones is very small in comparison with the dimensions of the arch. If we consider any portion HAh of the dome, it is plain that it presses on the course, of which HL is an arch-stone, in a direction bC perpendicular to the joint HI, or in the direction of the next superior element βb of the curve. As we proceed downwards, course after course, we see plainly that this direction must change, because the weight of each course is superadded to that of the portion above it, to complete the pressure on the course below. Through B draw the vertical line BCG, meeting βb, produced in C. We may take bC to express the pressure of all that is above it, propagated in this direction to the joint KL. We may also suppose the weight of the course HL united in b, and acting on the vertical. Let it be represented by bF. If we form the parallelogram bFGC, the diagonal bG will represent the direction and intensity of the whole pressure on the joint KL. Thus it appears that this pressure is continually changing its direction, and that the line, which will always coincide with it, must be a curve concave downward. If this be precisely the curve of the dome, it will be an equilibrated vaulting; but so far from being the strongest form, it is the weakest, and it is the limit to an infinity of others, which are all stronger than it. This will appear evident, if we suppose that bG does not coincide with the curve AbB, but passes without it. As we suppose the arch-stones to be exceedingly thin from inside to outside, it is plain that this dome cannot stand, and that the weight of the upper part will press it down, and spring the vaulting outwards at the joint KL. But let us suppose, on the other hand, that bG falls within the curvilinear element bB. This evidently tends to push the arch-stone inward towards the axis, and would cause it to slide in, since the joints are supposed perfectly smooth and slipping. But since this takes place equally in every stone of this course, they must all abut on each other in the vertical joints, squeezing them firmly together. Therefore, resolving the thrust bG into two, one of which is perpendicular to the joint KL, and the other parallel to it, we see that this last thrust is withstood by the vertical joints all around, and there remains only the thrust in the direction of the curve. Such a dome must therefore be firmer than an equilibrated dome, and cannot be so easily broken by overloading the upper part. When the curve is concave upwards, as in the lower part of the figure, the line bC always falls below bB, and the point C below B. When the curve is concave downwards, as in the upper part of the figure, b'C' passes above, or without bB. The curvature may be so abrupt, that even b'G' shall pass without b'B', and the point G' is above B'. It is also evident that the force which thus binds the stones of a horizontal course together, by pushing them towards the axis, will be greater in flat domes than in those that are more convex; that it will be still greater in a cone, and greater still in a curve whose convexity is turned inwards, for in this last case the line bG will deviate most remarkably from the curve. Such a dome will stand (having polished joints) if the curve springs from the base with any elevation, however small; nay, since the friction of two pieces of stone is not less than half of their mutual pressure, such a dome will stand although the tangent to the curve at the bottom should be horizontal, provided that the horizontal thrust be double the weight of the dome, which may easily be the case if it do not rise high.

Stability of a dome depends on principles different from that of a common arch.

40. Thus we see that the stability of a dome depends on very different principles from that of a common arch, and is in general much greater. It differs also in another very important circumstance, viz. that it may be open in the middle; for the uppermost course, by tending equally in every part to slide in toward the axis, presses all together in the vertical joints, and acts on the next course like the keystone of a common arch. Therefore an arch of equilibration, which is the weakest of all, may be open in the middle, and carry at top another building, such as a lanthorn, if its weight do not exceed that of the circular segment of the dome that is omitted. A greater load than this would indeed break the dome, by causing it to spring up in some of the lower courses; but this load may be increased if the curve is flatter than the curve of equilibration: and any load whatever, which will not crush the stones to powder, may be set on a truncate cone, or on a dome formed by a curve that is convex toward the axis; provided always that the foundation be effectually prevented from flying out, either by a hoop, or by a sufficient mass of solid pier on which it is set.

41. We have mentioned the many failures which happened to the dome of St Sophia in Constantinople. We imagine that the thrust of the great dome, bending the eastern arch outwards as soon as the pier began to yield, destroyed the half-dome which was leaning on it, and thus almost in an instant took away the eastern abutment. We think that this might have been prevented without any change in the injudicious plan, if the dome had been hooped with iron, as was practised by Michael Angelo in the vastly more ponderous dome of St Peter's at Rome, and by Sir Christopher Wren in the cone and the inner dome of St Paul's at London. The weight of the latter considerably exceeds 3000 tons, and they occasion a horizontal thrust which is nearly half this quantity, the elevation of the cone being about 60°. This being distributed

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round the circumference, occasions a strain on the hoop $= \frac{7}{2 \times 22}$ of the thrust, or nearly 238 tons. A square inch of the worst iron, if well forged, will carry 24 tons with perfect safety; therefore a hoop of 7 inches broad and $1\frac{1}{2}$ inch thick will completely secure this circle from bursting outwards. It is, however, much more completely secured; for, besides a hoop at the base of very nearly these dimensions, there are hoops in different courses of the cone, which bind it into one mass, and cause it to press on the piers in a direction exactly vertical. The only thrusts which the piers sustain are those from the arches of the body of the church and the transepts. These are most judiciously directed to the entering angles of the building, and are there resisted with insuperable force by the whole lengths of the walls, and by four solid masses of masonry in the corners. Whoever considers with attention and judgment the plan of this cathedral, will see that the thrusts of these arches, and of the dome, are incomparably better balanced than in St Peter's church at Rome. But to return from this sort of digression.

Theory of the curves proper for domes.

42. We have seen that if b G, the thrust compounded of the thrust b C, exerted by all the courses above HILK, and of the force b F, or the weight of that course, be everywhere coincident with b B, the element of the curve, we shall have an equilibrated dome: if it falls within it, we have a dome which will bear a greater load; and if it falls without it, the dome will break at the joint. We must endeavour to get analytical expressions of these conditions. Therefore draw the ordinates $b\,\delta\,b''$, BDB'', C d C''. Let the tangents at b and b'' meet the axis in M, and make MO, MP, each equal to bc, and complete the parallelogram MONP, and draw OQ perpendicular to the axis, and produce b F, cutting the ordinates in E and e.[1] It is plain that MN is to MO as the weight of the arch HAb to the thrust b C which it exerts on the joint KL (this thrust being propagated through the course HILK); and that MQ, or its equal $b\,e$, or $\delta\,d$, may represent the weight of the half HA.

Let AD be called x, and DB be called y. Then $be = dx$, and $e\,\mathrm{C} = dy$ (because b C is in the direction of the element $\beta\, b$). It is also plain that if we make dy constant, BC is the second fluxion of x, or BC $= d^2x$, and be and bE may be considered as equal, and taken indiscriminately for dx. We have also $b\,\mathrm{C} = \sqrt{dx^2+dy^2}$. Let h be the depth or thickness HI of the arch-stones. Then $h\sqrt{dx^2+dy^2}$ will represent the trapezium HL; and since the circumference of each course increases in the proportion of the radius y, $hy\sqrt{dx^2+dy^2}$ will express the whole course. If $\int$ be taken to represent the sum or aggregate of the quantities annexed to it, the formula will be analogous to the fluent of a fluxion, and $\int hy\sqrt{dx^2+dy^2}$ will represent the whole mass, and also the weight of the vaulting, down to the joint HI. Therefore we have this proportion, $\int hy\sqrt{dx^2+dy^2} : hy\sqrt{dx^2+dy^2} := b\,e : b\,\mathrm{F}, = b\,e : \mathrm{CG}, = \delta\,d : \mathrm{CG}, = dx : \mathrm{CG}$. Therefore $\mathrm{CG} = \frac{hydx\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}}$.

If the curvature of the dome be precisely such as puts it in equilibrium, but without any mutual pressure in the vertical joints, this value of CG must be equal to CB or to d^2x, the point G coinciding with B. This condition will be expressed by the equation $\frac{hydx\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}} = d^2x$, or, more conveniently, by $\frac{hy\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}} = \frac{d^2x}{dx}$. But this form gives only a tottering equilibrium, independent of the friction of the joints and the cohesion of the cement. An equilibrium, accompanied by some firm stability, produced by the mutual pressure of the vertical joints, may be expressed by the formula $\frac{hy\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}} > \frac{d^2x}{dx}$, or by $\frac{hy\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}} = \frac{d^2x}{dx} + \frac{dt}{t}$, where t is some variable positive quantity, which increases when x increases. This last equation will also express the equilibrated dome, if t be a constant quantity, because in this case $\frac{dt}{t}$ is $= 0$.

Since a firm stability requires that $\frac{hydx\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}}$ shall be greater than d^2x, and CG must be greater than CB; hence we learn that figures of too great curvature, whose sides descend too rapidly, are improper. Also, since stability requires that we have $\frac{hydx\sqrt{dx^2+dy^2}}{d^2x}$ greater than $\int hy\sqrt{dx^2+dy^2}$, we learn that the upper part of the dome must not be made very heavy. This, by diminishing the proportion of bF to bC, diminishes the angle CbG, and may set the point G above B, which will infallibly spring the dome in that place. We see here also, that the algebraic analysis expresses that peculiarity of dome-vaulting, viz. that the weight of the upper part may even be suppressed.

The fluent of the equation $\frac{hy\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}} = \frac{d^2x}{dx} + \frac{dt}{t}$ is most easily found: it is $\mathrm{L}\int hy\sqrt{dx^2+dy^2} = \mathrm{L}dx + \mathrm{L}t$, where L is the hyperbolic logarithm of the quantity annexed to it. If we consider dy as constant, and correct the fluent so as to make it nothing at the vertex, it may be expressed thus, $\mathrm{L}\int hy\sqrt{dx^2+dy^2} - \mathrm{L}a = \mathrm{L}dx - \mathrm{L}dy + \mathrm{L}t$. This gives us $\mathrm{L}\frac{\int hy\sqrt{dx^2+dy^2}}{a} = \mathrm{L}\frac{dx}{dy}t$, and therefore $\frac{\int hy\sqrt{dx^2+dy^2}}{a} = t\frac{dx}{dy}$.

This last equation will easily give us the depth of vaulting, or thickness h of the arch, when the curve is given. For its fluxion is $\frac{hy\sqrt{dx^2+dy^2}}{a} = \frac{dtdx + td^2x}{dy}$, and $h = \frac{adtdx + atd^2x}{ydy\sqrt{dx^2+dy^2}}$, which is all expressed in known quantities; for we may put in place of t any power or function of x or of y, and thus convert the expression into another, which will be applicable to all sorts of curves.

Instead of the second member $\frac{d^2x}{dx} + \frac{dt}{t}$, we might employ $\frac{pd^2x}{dx}$, where p is some number greater than unity. This will evidently give a dome having stability, because the original formula $\frac{hydx\sqrt{dx^2+dy^2}}{\int hy\sqrt{dx^2+dy^2}}$ will then be greater than d^2x. This will give $h = \frac{pax^{p-1}d^2x}{ydy^p\sqrt{dx^2+dy^2}}$. Each of these forms has its advantages when applied to particular cases. Each of them also gives $h = \frac{ad^2x}{ydy\sqrt{dx^2+dy^2}}$ when the curvature is such as is in precise equilibrium.

[1] The letters e and d are wanting in the plate; e ought to be at the intersection of b E and C c'', and d at that of AD and C c''.

And, lastly, if h be constant, that is, if the vaulting be of uniform thickness, we obtain the form of the curve, because then the relation of d^2x to dx and to dy is given.

The chief use of this analysis is to discover what curves are improper for domes, or what portions of given curves may be employed with safety. Domes are generally built for ornament, and we see that there is great room for indulging our fancy in the choice. All curves which are concave outwards will give domes of great firmness: they are also beautiful. The Gothic dome, whose outline is an undulated curve, may be made abundantly firm, especially if the upper part be convex and the lower concave outwards.

The chief difficulty in the case of this analysis arises from the necessity of expressing the weight of the incumbent part, or $\int hy\sqrt{dx^2+dy^2}$. This requires the measurement of the conoidal surface, which, in most cases, can be had only by approximation by means of infinite series. We cannot expect that the generality of practical builders are familiar with this branch of mathematics, and therefore will not engage in it here; but content ourselves with giving such instances as can be understood by such as have that moderate mathematical knowledge which every man should possess who takes the name of engineer.

The surface of any circular portion of a sphere is very easily had, being equal to the circle described with a radius equal to the chord of half the arch. This radius is evidently $=\sqrt{dx^2+dy^2}$.

In order to discover what portion of a hemisphere may be employed (for it is evident that we cannot employ the whole) when the thickness of the vaulting is uniform, we may recur to the equation or formula $\frac{hydx\sqrt{dx^2+dy^2}}{d\dot{x}^2}$ $=\int hy\sqrt{dx^2+dy^2}$. Let a be the radius of the hemisphere. We have $dx=\frac{aydy}{\sqrt{a^2-y^2}}$, and $d^2x=\frac{a^2dy^2}{(a^2-y^2)^{\frac{3}{2}}}$. Substituting these values in the formula, we obtain the equation $y^2\sqrt{a^2-y^2}=\int\frac{a^2ydy}{\sqrt{a^2-y^2}}$. We easily obtain the fluent of the second member $=a^3-a^2\sqrt{a^2-y^2}$, and $y=a\sqrt{-\frac{1}{2}+\sqrt{\frac{5}{4}}}$. Therefore, if the radius of the sphere be 1, the half breadth of the dome must not exceed $\sqrt{-\frac{1}{2}+\sqrt{\frac{5}{4}}}$, or 0·786, and the height will be ·618. The arch from the vertex is about 51° 49′. Much more of the hemisphere cannot stand, even though aided by the cement, and by the friction of the coursing joints. This last circumstance, by giving connection to the upper parts, causes the whole to press more vertically on the course below, and thus diminishes the outward thrust; but it at the same time diminishes the mutual abutment of the vertical joints, which is a great cause of firmness in the vaulting. A Gothic dome, of which the upper part is a portion of a sphere not exceeding 45° from the vertex, and the lower part is concave outwards, will be very strong, and not ungraceful.

Dome of St Peter's at Rome.

43. But the public taste has long rejected this form, and seems rather to select more elevated domes than this portion of a sphere, because a dome, when seen from a small distance, always appears flatter than it really is. The dome of St Peter's is nearly an ellipsoid externally, of which the longer axis is perpendicular to the horizon. It is very ingeniously constructed. It springs from the base perpendicularly, and is very thick in this part. After rising about 50 feet, the vaulting separates into two thin vaultings, which gradually separate from each other. These two shells are connected together by thin partitions, which are very artificially dovetailed in both, and thus form a covering which is extremely stiff, while it is very light. Its great stiffness was necessary for enabling the crown of the dome to carry the elegant stone lanthorn with safety. It is a wonderful performance and has not its equal in the world; but it is an enormous load in comparison with the dome of St Paul's, and this even independent of the difference of size. If they were of equal dimensions, it would be at least five times as heavy, and is not so firm by its gravity; but as it is connected in every part by iron bars (lodged in the solid masonry, and well secured from the weather by having lead melted all around them), it bids fair to last for ages if the foundations do not fail.

If a circle be described round a centre, placed anywhere in the transverse axis AC (Plate XLVIII. fig. 11) of an ellipse, so as to touch the ellipse in the extremities B, b of an ordinate, it will touch it internally, and the circular arch B a b will be wholly within the elliptical arch BAb. Therefore, if an elliptical and a spherical vaulting spring from the same base, at the same angle with the horizon, the spherical vaulting will be within the elliptical, will be flatter and lighter, and therefore the weight of the next course below will bear a greater proportion to the thrust in the direction of the curve; therefore the spherical vaulting will have more stability. On the contrary, and for similar reasons, an oblate elliptical vaulting is preferable to a spherical vaulting springing with the same inclination to the horizon. (Fig. 13.)

Dimensions of the best form of a dome.

44. Persuaded that what has been said on the subject convinces the reader that a vaulting perfectly equilibrated throughout is by no means the best form, provided that the base is secured from separating, we think it unnecessary to give the investigation of that form, which has a considerable intricacy, and shall content ourselves with merely giving its dimensions. The thickness is supposed uniform. The numbers in the first column of the table express the portion of the axis counted from the vertex, and those of the second column are the lengths of the ordinates.

AD	DB	AD	DB	AD	DB
0,4	100	610,4	1080	2990	1560
3,4	200	744	1140	3442	1600
11,4	300	904	1200	3972	1640
26,6	400	1100	1260	4432	1670
52,4	500	1336	1320	4952	1700
91,4	600	1522	1360	5336	1720
146,8	700	1738	1400	5756	1740
223,4	800	1984	1440	6214	1760
326,6	900	2270	1480	6714	1780
465,4	1000	2602	1520	7260	1800

The curve delineated in fig. 15 is formed according to these dimensions, and appears destitute of gracefulness, because its curvature changes abruptly at a little distance from the vertex, so that it has some appearance of being made up of different curves pieced together. But if the middle be occupied by a lanthorn of equal or of smaller weight, this defect will cease, and the whole will be elegant, nearly resembling the exterior dome of St Paul's in London.

Advantages of dome-vaulting.

45. It is not a small advantage of dome-vaulting, that it is lighter than any that can cover the same area. If, moreover, it be spherical, it will admit considerable varieties of figure by combining different spheres. Thus, a dome may begin from its base as a portion of a large hemisphere, and may be broken off at any horizontal

course, and then a similar or a greater portion of a smaller sphere may spring from this course as a base. It also bears being intersected by cylindrical vaultings in every direction, and the intersections are exact circles, and always have a pleasing effect. It also springs most gracefully from the heads of small piers, or from the corners of rooms of any polygonal shape; and the arches formed by its intersections with the walls are always circular and graceful, forming very handsome spandrels in every position. For these reasons Sir Christopher Wren employed it in all his vaultings, and he has exhibited many beautiful varieties in the transepts and the aisles of St Paul's, which are highly worthy of the observation of architects. Nothing can be more graceful than the vaultings at the ends of the north and south transepts, especially as furnished off in the fine inside view published by Gwynn and Wale.

Effects of cement and friction in dome-vaulting.

46. The connection of the parts arising from cement and from friction has a great effect on dome-vaulting. In the same way as in common arches and cylindrical vaulting, it enables an overload on one place to break the dome in a distant place. But the resistance to this effect is much greater in dome-vaulting, because it operates all round the overloaded part. Hence it happens that domes are much less shattered by partial violence, such as the falling of a bomb or the like. Large holes may be broken in them without much affecting the rest; but, on the other hand, it greatly diminishes the strength which should be derived from the mutual pressure in the vertical joints. Friction prevents the sliding in of the arch-stones, which produces this mutual pressure in the vertical joints, except in the very highest courses, and even there it greatly diminishes it. These causes make a great change in the form which gives the greatest strength; and as their laws of action are as yet but very imperfectly understood, it is perhaps impossible, in the present state of our knowledge, to determine this form with tolerable precision. We see plainly, however, that it allows a greater deviation from the best form than the other kind of vaulting, and domes may be made to rise perpendicular to the horizon at the base, although of no great thickness; a thing which must not be attempted in a plain arch. The immense addition of strength which may be derived from hooping largely compensates for all defects; and there are hardly any bounds to the extent to which a very thin dome-vaulting may be carried when it is hooped or framed in the direction of the horizontal courses. The roof of the Halle du Bled at Paris is but a foot thick, and its diameter is more than 200, yet it appears to have abundant strength. It is, on the whole, a noble specimen of architecture.

The iron bridge at Sunderland described.

47. We must not conclude this article without taking notice of that magnificent and elegant arch erected in cast iron at Wearmouth, near Sunderland, in the county of Durham. The inventor and architect was Rowland Burdon, Esq.

This arch (of which a view is given at the article BRIDGE) is a segment of a circle whose diameter is about 444 feet. The span or chord of the arch is 236 feet, and its versed sine or spring is 34 feet. It springs at the elevation of 60 feet from the surface of the river at low water, so that vessels of 200 or perhaps 300 tons burden may pass under it in the middle of the stream, and even 50 feet on each side of it.

The sweep of the arch consists of a series of frames of cast iron, which abut on each other, in the same manner as the voussoirs of a stone arch. One of these frames or blocks (as we shall call them in future) is represented in Plate XLIX. fig. 3, as seen in front. It is cast in one piece, and consists of three pieces or arms BC, BC, BC, the middle one of which is two feet long, the upper being somewhat more, and the lower somewhat less, because their extremities are bounded by the radius drawn from the centre of the arch. These arms are four inches square, and are connected by other pieces KL, of such length that the whole length of the block is five feet in the direction of the radius. Each arm has a flat groove on each side, which is expressed by the darker shading, three inches broad and three fourths of an inch deep. A section of this block, through the middle of KL, is represented by the light-shaded part BBB, in which the grooves are more distinctly perceived. These grooves are intended for receiving flat bars of malleable iron, which are employed for connecting the different blocks with each other. Fig. 4 represents two blocks united in this manner. For this purpose each arm has two square bolt-holes. The ends of the arms being nicely trimmed off, so that the three ends abut equally close on the ends of the next block; and the bars of hammered iron being also nicely fitted to their grooves, so as to fill them completely, and have their bolt-holes exactly corresponding to those in the blocks; they are put together in such a manner that the joints or meetings of the malleable bars may fall on the middle between the bolt-holes in the arms. Flat-headed bolts of wrought iron are then put through, and keys or forelocks are driven through the bolt-tails, and thus all is firmly wedged together, binding each arm between two bars of wrought iron. These bars are of such length as to connect several blocks.

In this manner a series of about 125 blocks are joined together, so as to form the precise curve that is intended. This series may be called a rib, and it stands in a vertical plane. The arch consists of six of these ribs, distant from each other five feet. These ribs are connected together so as to form an arch of 32 feet in breadth, in the following manner.

Fig. 5 represents one of the bridles or cross pieces which connect the different ribs, as it appears when viewed from below. It is a hollow pipe of cast iron four inches in diameter, and has at each end two projecting shoulders, pierced with a bolt-hole near their extremities, so that the distance between the bolt-holes in the shoulders of one end is equal to the distance between the holes in the arms of the blocks, or the holes in the wrought iron bars. In the middle of the upper and of the under side of each end may be observed a square prominence, more lightly shaded than the rest. These projections also advance a little beyond the flat of the shoulders, forming between them a shallow notch about an inch deep, which receives the iron of the arms, where they abut on each other, and thus give an additional firmness to the joint. The manner in which the arms are thus grasped by these notches in the bridles is more distinctly seen in fig. 4, at the letter H, in the middle of the upper rail.

The rib having been all trimmed and put together, so as to form the exact curve, the bolts are all taken out, and the horizontal bridles are then set on in their places, and the bolts are again put in and made fast by the forelocks. The bolts now pass through the shoulders of the bridles, through the wrought iron bars, and through the cast iron arm that is between them, and the forelocks bind all fast together. The manner in which this connection is completed is distinctly seen in fig. 4, which shows in perspective a double block in front, and a single block behind it. The abutting joints of the two front blocks are at the letters E, E, E; the holes in the shoulders of the horizontal cross pieces are at H.

48. This construction is beautifully simple, and very judicious. A vast addition of strength and of stiffness is procured by lodging the wrought iron bars in grooves

formed in the cast iron rails; and for this purpose it is of great importance to make the wrought iron bars fill the grooves completely, and even to be so tight as to require the force of the forelocks to draw them home to the bottom of the grooves. There can be no doubt but that this arch is able to withstand an enormous pressure, as long as the abutments from which it springs do not yield. Of this there is hardly any risk, because they are masses of rock, faced with about four or five yards (in some places only) of solid block masonry. The mutual thrusts of the frames are all in the direction of the rails, so that no part bears any transverse strain. We can hardly conceive any force that can overcome the strength of those arms by pressure or crushing them. The manner in which the frames are connected into one rib effectually secures the abutting joints from slipping; and the accuracy with which the whole can be executed secures us against any warping or deviation of a rib from the vertical plane.

But when we consider the prodigious span of this arch, and reflect that it is only five feet thick, it should seem that the most perfect equilibration is indispensably necessary. It is but like a film, and must be so supple, that an overload on any part must have a great tendency to bend it, and to cause it to rise in a distant part; and this effect is increased by the very firmness with which the whole sticks together. The overloaded part acts on a distant part, tending to break it with all the energy of a long lever. This can be prevented only by means of the stiffness of the distant part. It is very true, the arch cannot break in the extrados except by tearing asunder the wrought iron bars which connect the blocks along the upper rail, and each of these requires more than a hundred tons to tear it asunder; yet an overload of five tons on any rib at its middle will produce this strain at twenty feet from the sides, supposing the sides held firm in their position. It were desirable, therefore, that something were done to stiffen the arch at the sides, by the manner of filling up the spandrels or space between the arch and the road-way. This is filled up in a manner that is extremely light and pleasing to the eye, namely, by large cast iron circles, which touch the extrados of the arch and touch the road-way. The road-way rests on them as on so many hoops, while they rest on the back of the arch, and also touch each other laterally. We cannot think that this contributes to the strength of the arch; for these hoops will be easily compressed at the points of contact, and, changing their shape, will oppose very little resistance. We think that this part of the arch might have been greatly stiffened and strengthened by connecting it with the road-way by trussed frames, in the same way that a judicious carpenter would have framed a roof. If a strong cast iron pillar had been made to rest on the arch at about 20 feet from the impost, and been placed in the direction of a radius, the top of this pillar might have been connected by a diagonal bar of wrought iron with the impost of the arch, and with the crown of the arch by another string or bar of the same materials. These two ties would cause the radial pillar to press strongly on the back of the arch, and they must be torn asunder before it could bend in that place in the smallest degree. Supposing them of the same dimensions as the bars in the arms, their position would give them near ten times the force for resisting the strain produced by an overload on the crown.

This beautiful arch contains only 260 tons of iron, of which about 55 are wrought iron. The superstructure is of wood, planked over a top. This floor is covered with a coating of chalk and tar, on which are laid the materials for the carriage road, consisting of marl, limestone, and gravel, with foot-ways of flag-stones at the sides. The weight of the whole did not exceed 1000 tons, whereas the lightest stone arch which could have been erected would have weighed 15,000. It was turned on a very light but stiff scaffolding, most judiciously constructed for the preservation of its form, and for allowing an uninterrupted passage for the numerous ships and small craft which frequent the busy harbour of Sunderland. The mode of framing the arch was so simple and easy that it was put up in ten days, without an accident; and when all was finished, and the scaffolding removed, the arch did not sensibly change its form. The whole work was executed in three years, and cost about L.26,000.

Appendix.

49. The excellence of the preceding article, written by the late Dr John Robison, Professor of Natural Philosophy in the University of Edinburgh, for the Supplement to the third edition of this work, may be inferred from the fact, that almost every later writer on mechanics has spoken of it with approbation, and borrowed more or less from it. (See Gregory's *Mechanics*, book i. chap. 6; Hutton's *Tracts*, vol. i., Bridges; Whewell's *Mechanics*, art. 72, &c.) There is however one part of the article, viz. the purely mathematical part, which must have been quite unintelligible as it originally appeared, because of its numerous typographical errors. These are here corrected, we believe for the first time. Even with this advantage, we fear it has rather a forbidding aspect to the student of modern mathematics, because of the very complicated diagram (see Plate XLVIII. fig. 12) from which the differential equation of the equilibrated arch has been deduced. We shall therefore, as an appendix, treat of the equilibrated polygon and equilibrated arch upon the general principles of statics, and employ in this investigation only the most simple geometrical figures. The theory of the equilibrated arch cannot be delivered without employing the principles of the differential and integral calculus; but we shall endeavour to pass from the finite equation of the equilibrated polygon to the differential equation of the arch by the shortest and most direct road.

Equilibrated Polygon.

50. In Plate XLIX. fig. 9, let ABCDED′C′B′A′ be a polygon formed by beams or rods AB, BC, CD, DE, &c. of any length, movable about the points B, C, D, E, &c. as joints, and forming an equilibrium in a vertical plane by the mutual thrusts at the joints and by the weight of the beams, the extreme sides of the polygon being supposed supported or attached to fixed points. Let AB, BC, CD, be any three consecutive sides of the polygon: produce AB, DC, the extreme sides, until they meet in H. The beam BC is kept in its position by the thrusts of the adjoining beams AB, CD, in the directions BH, CH, and its own weight, which is equivalent to pressures or loads on the joints B, C, acting in a vertical direction. Let G be the point in BC, which is the centre of gravity of weights proportional to loads at B and C. By the principles of statics, the directions of these forces must pass through the same point; therefore G must be in a vertical line passing through H.

51. Draw BL, CK, perpendicular to the vertical HG. Let φ, φ', φ'', denote the angles which the lines AB, BC, CD, in their order, make with any horizontal line in the plane of the polygon; then

$\varphi =$ angle HBL, $\varphi' =$ GBL $=$ GCK, $\varphi'' =$ HCK:

also let w denote the load on the joint B, and w' the load on the joint C.

By the nature of the centre of gravity,

$$w : w' = CG : BG = CK : BL,$$

therefore $w : w' = \frac{1}{BL} : \frac{1}{CK} = \frac{HG}{BL} : \frac{HG}{CK}$:

$$\text{Now } \frac{HG}{BL} = \frac{HL}{BL} - \frac{GL}{BL} = \tan.\ \varphi - \tan\ \varphi'$$

$$\text{and } \frac{HG}{CK} = \frac{GK}{CK} - \frac{HK}{CK} = \tan.\ \varphi' - \tan.\ \varphi'';$$

hence it appears that

$$w : w' = \tan.\ \varphi - \tan.\ \varphi' : \tan.\ \varphi' - \tan.\ \varphi''.$$

If w'' denote the load on the next joint D, and φ''' the angle which the line DE makes with the horizontal plane, it will appear in the same way that

$$w' : w'' = \tan.\ \varphi' - \tan.\ \varphi'' : \tan.\ \varphi'' - \tan.\ \varphi''',$$

and so on throughout the whole polygon: whence we have this important proposition:

The vertical pressures on any two joints of the polygon, whether adjoining or remote, are to one another as the differences of the tangents of the angles which the sides about the joints make with the plane of the horizon.

52. From this proposition we may infer, that if φ, φ' denote the angles which any two adjoining sides of the polygon make with the horizontal plane, and w the load on the joint at their intersection, then,

$$w = C\ (\tan.\ \varphi - \tan.\ \varphi') \ldots\ldots\ldots\ldots (A);$$

and in this formula, C denotes some constant quantity, which is the same for all the angles of the polygon. This is the general equation of the equilibrated polygon; and it shows that the loads at the joints depend entirely on the angles which the beams make with the horizontal plane, and are independent of the lengths of the beams themselves.

Equilibrated Arch.

53. We shall next investigate the differential equation of an equilibrated arch, deducing it from the finite equation of the equilibrated polygon.

Let us suppose an equilibrated polygon of a very great number of sides (fig. 10), and that a curve ABC passes through all the joints: the sides of the polygon will then be chords in the curve; and as the number of these may be conceived to be greater than any assigned number, and each shorter than any given line, they may be regarded as elements of the curve, and as constituting it.

54. Let us suppose the curve ABC formed in this manner to be the intrados of an arch of a bridge, and that the extrados is the line MDN, which may be curved or straight. Let AC be the *span*, or greatest horizontal width of the arch, and BH, which bisects AC at right angles, its *rise* or height; also let BD be the thickness of the arch of the crown: draw a straight line EDF perpendicular to DH, and draw AE, CF perpendicular to EF.

Let Pp be any indefinitely small part of the intrados ABC. Draw PRQ perpendicular to the horizontal line EF, meeting the extrados in R, and rp parallel to RP; also draw PK perpendicular to DH, meeting rp in q, and PT touching the intrados in p; and, referring the two curves to the same axes DE, let us put

$x =$ DQ the common abscissa,
$y =$ PQ the ordinate of the intrados,
$v =$ RQ the ordinate of the extrados,
$\varphi =$ angle TPK made by the tangent and horizontal line PK,
$c =$ DB the given value of y at the crown,
$c' =$ AE the given value of y at either haunch.

Then, because Pp is a differential of the arc BP, we have P$q = dx$, and $pq = dy$.

55. The load on the arc BP is the gravitating matter between it and DR, the arc of the extrados immediately over it. This is expressed by the area BDRP; therefore the load on Pp, the differential of the arc, is $(y - v)dx$, the differential of that area.

We have put φ to denote the angle which a tangent at P makes with any horizontal line; similarly, let φ' denote the angle which a line touching the curve at p makes with a horizontal line. If now the curve be considered as a polygon of an infinite number of infinitely short sides, and the lines which touch the curve at P and p as the prolongations of two adjoining sides, then, by formula (A), sect. 52, the vertical pressure at their intersection will be C (tan. φ — tan. φ'). But these infinitely short touching lines may be regarded as forming Pp, the differential of the curve, the load on which we have found to be $(y - v)dx$; and, moreover, $\tan.\ \varphi - \tan.\ \varphi' = d(\tan.\ \varphi)$, the differential of the trigonometrical tangent of φ; therefore, the relation between the intrados and extrados will be expressed by this equation,

$$C\, d(\tan.\ \varphi) = (y - v)dx.$$

Now in all curves, $\tan.\ \varphi = \frac{dy}{dx}$, and making dx constant, $d(\tan.\ \varphi) = \frac{d^2y}{dx}$, let us, to make the members of the equation homogeneous, put c^2 instead of C, which is always positive, and the above equation becomes

$$c^2 \frac{d^2y}{dx} = (y - v)dx;$$

and hence

$$\frac{d^2y}{dx^2} - \frac{y}{c^2} = -\frac{v}{c^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (B).$$

This differential equation, which is of the second order, and *linear*, or of the first degree, comprehends in it the whole theory of the equilibrated arch. We may now deduce from it the resolution of two problems.

Prob. 1. Having given the form of the intrados ABC, to find that of the extrados.

Prob. 2. Having given the nature of the extrados, to determine the intrados.

56. The first problem is easy, and may be resolved by the differential calculus.

Ex. Let the intrados ABC be a segment of a circle whose centre is O. Draw PO to the centre. Let $\varphi =$ angle POB, and $a =$ PO the radius of the circle; then,

$$x = DQ = PK = a \sin.\ \varphi,$$
$$y = PQ = BD + BK = c' + a\ (1 - \cos.\ \varphi),$$
$$dx = a \cos.\ \varphi\, d\varphi, \qquad dy = a \sin.\ \varphi d\varphi,$$
$$\frac{dy}{dx} = \frac{\sin.\ \varphi}{\cos.\ \varphi} = \tan.\ \varphi; \quad \frac{d^2y}{dx} = \frac{d\varphi}{\cos.^2\varphi},$$
$$\frac{d^2y}{dx^2} = \frac{1}{a \cos.^3 \varphi} = \frac{\sec.^3 \varphi}{a}.$$

Now, by formula (B),

$$\frac{y - v}{c^2} = \frac{d^2y}{dx^2} = \frac{\sec.^3 \varphi}{a};$$

therefore $y - v = \frac{c^2}{a} \sec.^3 \varphi$.

But when $x = 0$, then $v = 0$, $y = c'$, $\varphi = 0$, and $\sec.\ \varphi = 1$;

therefore $c' = \frac{c^2}{a}$ and $c^2 = ac'$; hence we have

$$v - y = c' \sec.^3 \varphi.$$

This shows that the vertical line between the intrados and extrados is always proportional to the cube of the secant of the angle which the radius OP makes with the perpendicular; a conclusion which agrees with section 25 of the preceding article.

57. The second problem, viz. having given the nature

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of the extrados, to find that of the intrados, is the more important of the two, and more difficult. Its solution requires the integral calculus; but the difficulty is no greater than that of finding the area of a curve whose equation is given. This can always be accomplished, if not in finite terms, at least by infinite series. We shall now give a general solution of the problem.

Lagrange has shown (*Théorie des Fonctions Analytiques*, chap. viii.) that the integration of the equation

$$\frac{d^2y}{dx^2}-\frac{y}{c^2}=\mathrm{X},$$

(where X denotes an explicit function of the variable x), can always be accomplished when two particular integrals of this other equation, viz.

$$\frac{d^2y}{dx^2}-\frac{y}{c^2}=0,$$

are known. Now $y=pe^{\frac{x}{c}}$ and $y=qe^{-\frac{x}{c}}$ are such integrals (p and q being arbitrary constants, and $e=2\cdot7182818$, the number whose Napierian logarithm is unity), as may be proved by differentiation; therefore, following Lagrange, to integrate the equation (B), viz.

$$\frac{d^2y}{dx^2}-\frac{y}{c^2}=-\frac{v}{c^2},$$

we assume

$$y=pe^{\frac{x}{c}}+qe^{-\frac{x}{c}}$$

for the complete integral equation; but now p and q are to be considered as functions of the variable x. To determine these, we differentiate, and get

$$\frac{dy}{dx}=\frac{1}{c}\left\{pe^{\frac{x}{c}}-qe^{-\frac{x}{c}}\right\}+e^{\frac{x}{c}}\frac{dp}{dx}+e^{-\frac{x}{c}}\frac{dq}{dx}:$$

Since p and q are indeterminate functions of x, we may assume that

$$e^{\frac{x}{c}}\frac{dp}{dx}+e^{-\frac{x}{c}}\frac{dq}{dx}=0,$$

and then we have

$$\frac{dy}{dx}=\frac{1}{c}\left\{pe^{\frac{x}{c}}-qe^{-\frac{x}{c}}\right\}:$$

Again, by differentiating, we find

$$\frac{d^2y}{dx^2}=\frac{1}{c^2}\left\{pe^{\frac{x}{c}}+qe^{-\frac{x}{c}}\right\}+\frac{1}{c}\left\{e^{\frac{x}{c}}\frac{dp}{dx}-e^{-\frac{x}{c}}\frac{dq}{dx}\right\}$$

$$=\frac{y}{c^2}+\frac{1}{c}\left\{e^{\frac{x}{c}}\frac{dp}{dx}-e^{-\frac{x}{c}}\frac{dp}{dx}\right\}.$$

This result, compared with equation (B), gives

$$\frac{1}{c}\left\{e^{\frac{x}{c}}\frac{dp}{dx}-e^{-\frac{x}{c}}\frac{dq}{dx}\right\}=-\frac{v}{c^2}.$$

From this and the equation

$$e^{\frac{x}{c}}\frac{dp}{dx}+e^{-\frac{x}{c}}\frac{dq}{dx}=0,$$

we obtain $\left(\text{putting } \mathrm{X}=-\frac{v}{c^2}\right)$

$$\frac{dp}{dx}=\frac{c}{2}e^{-\frac{x}{c}}\mathrm{X},\qquad \frac{dq}{dx}=-\frac{c}{2}e^{\frac{x}{c}}\mathrm{X},$$

$$p=\frac{c}{2}\int e^{-\frac{x}{c}}\mathrm{X}dx+b;\ q=-\frac{e}{2}\int e^{\frac{x}{c}}\mathrm{X}dx+b'.$$

Here b and b' are arbitrary constants, and the integrals are supposed to be taken so as to vanish when $x=0$. The complete integral equation is now

(C)

$$y=be^{\frac{x}{c}}+b'e^{-\frac{x}{c}}+\frac{c}{2}\left\{e^{\frac{x}{c}}\int e^{-\frac{x}{c}}\mathrm{X}dx-e^{-\frac{x}{c}}\int e^{\frac{x}{c}}\mathrm{X}dx\right\}.$$

To determine the arbitrary constants b and b', we must consider that a tangent to the intrados at the vertex is perpendicular to the vertical DH; therefore, when $x=0$, then $\frac{dy}{dx}=0$; but from the equation just found we get

$$\frac{dy}{dx}=\frac{1}{c}\left\{be^{\frac{x}{c}}-b'e^{-\frac{x}{c}}\right\}+\tfrac{1}{2}\left\{e^{\frac{x}{c}}\int e^{-\frac{x}{c}}\mathrm{X}dx+e^{-\frac{x}{c}}\int e^{\frac{x}{c}}\mathrm{X}dx\right\}.$$

Now, when $x=0$, then $e^{\frac{x}{c}}=1$, and $e^{-\frac{x}{c}}=1$; and by hypothesis the integrals $\int e^{\frac{x}{c}}\mathrm{X}dx, \int e^{-\frac{x}{c}}\mathrm{X}dx$ in this particular case vanish; therefore, when $x=0$, the last equation becomes $0=b-b'$, so that $b'=b$. But again, in the general equation (C), when $x=0$, then $y=c'$; therefore we have also $c'=2b$ and $b=\frac{1}{2}c'$. On the whole, the equation of the extrados is

(D)

$$y=\frac{c'}{2}\left\{e^{\frac{x}{c}}+e^{-\frac{x}{c}}\right\}+\frac{c}{2}\left\{e^{\frac{x}{c}}\int e^{-\frac{x}{c}}\mathrm{X}dx-e^{-\frac{x}{c}}\int e^{\frac{x}{c}}\mathrm{X}dx\right\};$$

the integrals being taken so as to vanish when $x=0$. We have thus brought the solution to depend on the integration of the two differentials

$$e^{\frac{x}{c}}\mathrm{X}dx,\quad e^{-\frac{x}{c}}\mathrm{X}dx,$$

which in fact will only differ in their sign, because the branches of the extrados on opposite sides of the vertical are exactly alike, and therefore the substitution of $-x$ for $+x$ will not change the sign of u nor of X. Now this integration can always be effected by known methods, therefore the second problem may be regarded as completely resolved.

57. *Example.* Let us suppose that the extrados is a horizontal straight line EF.

The line PT being supposed to touch the curve, let us as before put

$c'=\mathrm{DB}$, $c''=\mathrm{EA}$, $s=\mathrm{DE}$,
$x=\mathrm{DQ}$, $y=\mathrm{PQ}$, $\varphi=$ angle TPK.

In this case $v=0$ and $\mathrm{X}=0$, and the equation of the curve is simply

$$y=\frac{c'}{2}\left\{e^{\frac{x}{c}}+e^{-\frac{x}{c}}\right\}.$$

This case of the general problem has been resolved in sect. 25; the equation of the curve is, however, here given under a different form. We shall now deduce from it a formula for logarithmic calculation.

In all curves, tan. $\varphi=\frac{dy}{dx}$; in the present case

$$\tan.\varphi\left(=\frac{dy}{dx}\right)=\frac{c'}{2c}\left\{e^{\frac{x}{c}}-e^{-\frac{x}{c}}\right\}:$$

Let ψ be such an angle that

$e^{\frac{x}{c}}=\tan.(45^\circ+\frac{1}{2}\psi)$, then $e^{-\frac{x}{c}}=\tan.(45-\frac{1}{2}\psi)$.

Hence, by the arithmetic of sines (ALGEBRA, sect. 244, (K) and sect. 240, (C) No. 1),

$$e^{\frac{x}{c}}+e^{-\frac{x}{c}}=\frac{1}{\cos.(45^\circ+\frac{1}{2}\psi)\cos.(45^\circ-\frac{1}{2}\psi)}=\frac{2}{\cos.\psi}=2\sec.\psi$$

$$e^{\frac{x}{c}}-e^{-\frac{x}{c}}=\frac{\sin.\psi}{\cos.(45^\circ+\frac{1}{2}\psi)\cos.(45^\circ-\frac{1}{2}\psi)}=\frac{2\sin.\psi}{\cos.\psi}=2\tan.\psi$$

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Also, by the theory of logarithms (Algebra, sect. xix.),

$$\frac{x}{c}\log. e = \log. \frac{\tan. (45° + \frac{1}{2}\psi)}{\text{rad.}} = \log. \tan. (45° + \tfrac{1}{2}\psi) - 10.$$

From these expressions we obtain the relation of the three principal elements of the curve, viz. φ, x, y, as follows:

$$\tan. \psi = \frac{c}{c'} \tan. \varphi \ldots\ldots (1)$$

$$x = \frac{c}{\log. e}\left\{\log. \tan. (45°+\tfrac{1}{2}\psi) - 10\right\} \ldots (2)$$

$$y = \frac{c'}{\cos. \psi} = d \sec. \psi \ldots\ldots (3)$$

But before these formulæ can be applied, the value of c must be known. To find this, let α denote the value of ψ when $x = s$ and $y = c''$; then equations (3) and (2) become

$$c'' = \frac{c'}{\cos. \alpha}$$

$$s = \frac{c}{\log. e}\left\{\log. \tan. (45°+\tfrac{1}{2}\alpha) - 10\right\}$$

From these we obtain

$$\cos. \alpha = \frac{c'}{c''} \ldots\ldots (4)$$

$$c = \frac{\log. e}{\log. \tan. (45°+\frac{1}{2}\alpha) - 10} s \ldots\ldots (5)$$

These formulæ determine c, and this known, the values of x and y corresponding to any proposed value of φ may be readily found from formulæ (1) (2) and (3).

58. We may also determine y directly from x without φ by eliminating $\frac{c}{\log. e}$ by formulæ (2) and (5); we have then, to determine y from x, these formulæ,

$$\cos. \alpha = \frac{c'}{c''} \ldots\ldots (a)$$

$$\log. \tan. (45°+\tfrac{1}{2}\psi) = 10 + \frac{x}{s}\left\{\log. \tan. (45°+\tfrac{1}{2}\alpha) - 10\right\} (b)$$

$$y = \frac{c'}{\cos. \psi} \ldots\ldots (c)$$

1. As an example, let us take the case of Blackfriars Bridge, for which a table of corresponding values of x and y has been given, sect. 26. Here the span is 100 feet, the height or rise forty feet, and the thickness at the crown six feet; and first, let it be required to find the ordinate y, when $x=20$ feet; we have now

$$s=50,\ c'=6,\ c''=46,\ x=20,\ \frac{x}{s}=\frac{20}{50}.$$

Logarithmic Calculation.

$c'=6$	0·7781512
$c''=46$	1·6627578
$\cos. (\alpha=82° 30' 19'')$	9·1153934
$\log. \tan. (45°+\frac{1}{2}\alpha=86° 15' 9''\cdot5)-10=$	1·1837773
To	10·0000000
add $\frac{20}{50} \times 1.1837773 =$	0·4735109
$\tan. (45°+\frac{1}{2}\psi=71° 25' 18'')$	10·4735109
$\cos. (\psi=52° 50' 36'')$	9·7810344
$y=\frac{c'}{\cos. \psi}=9\cdot9338$ feet	0·9971168

The greater part of the above calculation serves for all the values of x, and need not be repeated in constructing a table of the ordinates.

2. Let it be required to find y when $x=32$ feet.

To	10·0000000
add $\frac{32}{50} \times 1\cdot1837773=$	0·7576175
$\tan. (45°+\frac{1}{2}\psi=80° 5' 18'')$	10·7576175
$c'=6$	0·7781512
$\cos. (\psi=70° 10' 36'')$	9·5303431
$y=17\cdot6933$ feet	1·2478081

In this way may all the numbers in the table of sect. 26. be computed with greater expedition than by the formula given there.

The value of φ to each value of x may be found from formulæ (5) and (1) of last article. (J. R.) (W. W.)

Arch, *Triumphal*, a monumental structure erected in commemoration of a victory or other memorable historical event.

These originated in ancient times in the military triumphs of the Romans, with whom it was customary to adorn the gate by which a victorious general entered the city with trophies and representations of the conquest he had achieved. These temporary memorials soon gave place to more enduring monuments of stone and marble. The triumphal arch (*Arcus triumphalis*) was built across some one of the principal streets, and consisted either of a single large archway or of a central one with two smaller ones on each side, communicating generally with the larger passage. Sometimes there were two arches of equal height side by side. Both faces of the arch and the sides of the passages were ornamented with trophies and sculptures. Above the façades, supported on columns, was an entablature surmounted by an attic crowned with figures, and bearing the inscription on its front.

The most celebrated surviving monuments of this description are the Arch of Augustus at Rimini, and another at Susa (at the foot of Mount Cenis), the arches of Trajan at Beneventum and Ancona, of Titus, Drusus, Septimius Severus, Gallienus, and Constantine, at Rome. Of these the arch of Titus is the oldest and the finest specimen of this kind of structure. It commemorates his conquest of Judæa, and is adorned with highly-finished sculptures, representing the triumphal procession of the trophies of Jerusalem. The arch of Constantine, however, is the most perfect in preservation of all the ancient Roman arches.

Remains of Roman arches are also to be seen in France, Spain, Greece, Istria, Dalmatia, and Egypt. See Orange, Rheims, Merida, &c.

In modern times structures of this kind have been erected in Italy, as that of king Alphonso at Naples; and at Berlin, at the entrance of the royal palace. The capital of France, however, possesses more of them than any other modern city. Of these the most worthy of mention are the arches of the Portes St Denis and St Martin, erected in 1673 and 1674 to commemorate the victories of Louis XIV., and the Arc du Carrousel, begun in 1806, and finished in 1809, in honour of the armies of France. This graceful monument, which forms the western entrance to the Tuileries, consists of three arches, the total height of the structure being 47 feet, and its breadth 55. The two principal faces are adorned

by eight Corinthian columns in Languedoc marble, surmounted by statues. The structure is crowned by a spirited equestrian group in bronze, consisting of a chariot drawn by four horses, guided by the allegorical figures of Victory and Peace. The marble bas-reliefs were executed by the best sculptors of the imperial epoch. But the colossal *Arc d'Étoile*, at the extremity of the *Avenue des Champs Elysées*, is the grandest monument of the kind erected in modern times. It commemorates the victories of Napoleon and his armies, and was begun in 1806, but not completed till after the Revolution of 1830. Its form is that of a parallelogram, its height and its breadth about 150 feet. It consists of three arches, the height of the central one being 95 feet, and that of the lateral arches 52. Its eastern and western fronts are adorned by colossal allegorical groups in relief; above them are bas-reliefs representing some of the most striking scenes in the imperial wars. The frieze which runs all round the structure is of the same description. The attic is adorned with bucklers inscribed with the names of victories. The interior of the arch is likewise inscribed with the names of Buonaparte and his generals. A stair inside conducts to the top of the building.

The arch at Hyde-Park Corner, surmounted by the colossal equestrian statue of the Duke of Wellington, and the Cumberland Gate, are the only representatives of this kind of structure in our country.

Arch, from the Greek ἀρχός, a prefix of many English words, used to signify chief, or of the first rank.

ARCHÆOLOGY, from ἀρχαῖος ancient, and λόγος a description. The term *Archæology*, like that of *Antiquities*, has been employed, until a very recent period, in a sense so restricted and arbitrary, as strikingly to contrast with the latitude admissible according to the original derivation of the word. Where any attempt has been made to assign precise limits, it has most frequently been reserved as the exclusive designation of Greek and Roman antiquities, though its fitness for the most comprehensive definition in relation to all which pertains to the past has not escaped the attention of scientific writers; and it is even employed by Dr Pritchard, on several occasions, as nearly synonymous with palæontology. In this use of it, however, he has not been followed, and the term is now universally adopted to designate the science which deduces history from the relics of the past. So comprehensive a subject necessarily admits of great subdivision, and some of the most important branches of the study will be found treated of under the heads of Egyptian, Etruscan, Assyrian, Mexican, Indian, Greek, and Roman antiquities.

The aspiration of the human mind after some knowledge of the mysteries of the future is not more innate or universal than the desire to recover the secrets of the past. The question *Whence?* no less than that of *Whither?* is found to give shape to the mythic legends of the rude barbarian, and to constitute an important element in the poetry and mythology which are the beginnings of every nation's oral and written history. With the progress of society the value of such indices of the past becomes apparent, and we accordingly find abundant traces of an archæological spirit in the literature of every civilized nation. The influence of the same spirit no less invariably marks every epoch of great progress. The revival of arts and letters in the thirteenth and fourteenth centuries was alike signalized by a renewed appreciation of Greek and Roman models; and while the progress of opinion in the fifteenth century was accompanied by an abandonment of medieval for classic art, the tendency of Europe in our own day, amid many elements of progress, has been singularly consentaneous in the return to medieval art, and the attempt to attain to higher excellence than has yet been achieved, by a more perfect development of the ideal of the middle ages.

It is mainly owing to the successful labours of the geologist that archæology has been so extended as to embrace the entire range of human history, and has at length been developed as a systematic science, by which the intelligent investigator is enabled to pursue his researches among records long preceding all written annals; and thereby to recover chapters in the history of nations heretofore deemed irrecoverable. The geologist, with no aid from written records, follows out his inquiries through successive periods in the history of the preadamite world, and reveals to us the character of the living beings which animated those long-past epochs of the globe. Beginning with the first traces of life in the primary fossiliferous strata, the geologist passes on from system to system, revealing a wondrous process of development, and disclosing to us marvellous revelations of long extinct being, until at length in the latest diluvial formations he points to the remains of animals identical with existing species, and even to traces of human art—the evidences of the close of geological, and the beginning of archæological periods. Here, at least, archæological science ought to be ready to take up the narrative at the close of those geological chapters; and with a minuteness of detail, and a certainty as to conclusions, unknown to the elder science. Such, however, has not been the case until very recently. The British geologist, pausing at the dawn of the historic or human period, turned to the archæologist for the remaining chapters of the history of life on our globe, and received for answer a record of Roman traces but meagrely supplementing the minuter details of recorded events. Nearly the same was the case with all historic antiquity, with the single exception of the wonderful monuments of Egypt, which still preserve to us the records of a civilization going back nearly to the emergence of our globe from the waters of the Mosaic deluge.

The traces of the primitive arts and civilization of the aborigines of Europe were long familiar to the antiquary, before any intelligent conception was formed of their value as historic records. The interpretation of these is mainly due to the successful labours of the archæologists and ethnologists of Denmark and Sweden, added to the spirited co-operation of zealous British coadjutors. By these investigators the remains of primitive art have been brought under a systematic classification, and thus the desultory and often misdirected labours of the antiquary have given place to researches characterized by a scientific accuracy in no degree inferior to that of the most careful palæontologist.

This system of Primitive Archæology is arranged into three great divisions, entitled the Stone, the Bronze, and the Iron periods, warranted alike by evidence, and by its practical convenience. The Stone Period, as the name implies, is that in which the rude aboriginal arts, which the commonest necessities of man call into operation, are assumed to have been employed entirely on such natural materials as stone, horn, bone, &c. The Bronze Period is that era of progress in which the metallurgic arts appear to have been introduced and slowly developed; and the Iron Period is that of matured metallurgic arts, and the accompanying progress consequent on the degree of civilization which is the necessary concomitant of such a state of things. All these periods embrace eras of national history concerning which no contemporary written records exist, and in relation to most of which, and especially to those of the first two periods, nearly as little is known from any other source as of the Palæozoic or Carboniferous periods of the geologist. It need not, therefore, excite surprise that the process of historic induction pursued on this basis has been called in question by historical writers of very high standing, but whose exclusive labours on the records of periods admitting of documentary evidence and charter-proof render them little disposed to sympathize in a course of induction in relation to human history, such as has in the hands of the

geologist revealed so much in relation to more ancient life. By these the system of archæological periods has been assailed as a visionary and illusive theory, without foundation in truth. That it is no baseless theory, however, is sufficiently manifest from the fact that no primitive and barbarous people has been met with in modern times, cut off from intercourse with civilized nations, among whom any knowledge of the metallurgic arts exist; and no partially civilized people, when similarly isolated, appears to have acquired the art of smelting and working the iron ore.

The Esquimaux, the Red Indians of America, and the whole widely-scattered races of the Polynesian Islands, were, when first discovered, without any knowledge of the metals, and supplied all their wants by means of implements and weapons of stone, shell, bone, or wood. The civilized Mexicans and Aztecs, on the contrary, when first visited by the Spaniards, in the fifteenth century, were familiar with the working of copper as well as gold; though totally ignorant of iron, and also retaining for common purposes many of the primitive stone weapons and implements. Greece passed from its bronze to its iron age within the period embraced in its literary history; and the mastery of the art of working the intractable iron ore is traceable with tolerable clearness in the early history of Rome, not very long before it came in contact with the transalpine barbarians. Among most of these Germanic and Celtic tribes, iron appears to have been already known when they first came in contact with the aggressive civilization of the south, and from one of them, the Norici (in whose country, in the Austrian valleys of the Danube, this metal is still wrought with the highest skill), we have reason to believe that the Romans acquired the art of making steel.

If history is only to begin, as that of our own country has been made to do, with the date of the first collision with invading Rome, then, no doubt, Stone and Bronze periods are as useless and meaningless as are the Eocene and Miocene periods, to the geologist who assigns the Mosaic deluge as the source of the earliest phenomena of his science. To those, however, who are willing to follow inductive reasoning to its legitimate conclusions, it must be apparent that it is no visionary theory, but a system founded in well-established truth, which arranges the archæological records of primitive history, and the remains of human art, into Stone, Bronze, and Iron periods. There is only one important distinction to be made in the use of such materials as a basis of inductive reasoning, and of those with which the palæontologist deals. The geological formations, with their included organic remains, obey a natural and unvarying order, and however widely apart similar formations may be found, they are assumed to be of contemporaneous origin. But, geologically speaking, the entire history of the human race is embraced in one period; while in the works of art, which form the basis of archæological induction, a new element—that of mind, or the reasoning faculty, along with the imitative and social arts—is introduced, and greatly complicates its subdivisions. The Stone period of Britain or Denmark is precisely analogous to that of the Polynesian Islands. So closely do their tools and weapons resemble each other, that it requires a practised eye to distinguish the stone axe or flint lance-head found in an ancient British barrow, from implements brought by some recent voyager from the islands of the Southern Ocean. The inference is manifestly legitimate, that in these South Sea Islanders we have examples of a people in the same primitive stage as were the aborigines of Europe during its Stone period. Chronologically, however, the Stone periods of the north of Europe and of the Pacific are probably separated by upwards of two thousand years. In like manner, the Bronze age of Mexico was still undisturbed by all later elements, when first brought into contact with the matured civilization of Europe in the fifteenth century, while the close of that of Britain preceded the first century of our era. The same rule is applicable to the primitive archæology of all countries; and a fertile source of error and misconception has already had its rise in the assumption, that because Greece and Italy, Germany, Gaul, Scandinavia, and Britain, have all had their primitive Stone and Bronze periods, therefore, the whole must have been contemporaneous. It cannot, therefore, be too strongly enforced as one of the most essential points of variance in the reasoning of the geologist and the archæologist, that the eras of the latter, though synonymous, are not necessarily synchronous, like those of the former; but that, on the contrary, nearly all the phenomena which pertain to the *natural history* of man, and to the historic development of the race, may be witnessed in their various stages in contemporary races of our own day: from the rudimentary barbarism, and the absence of all arts essential to the first dawn of civilization, to the state of greatest advancement in the knowledge and employment of such arts.

Some progress has already been made in an approximation to certain chronological data of much importance, relative to such primitive periods of the history of nations. Geological evidence of changes occurring within the historic period supplies somewhat of this important clue, when accompanied with the traces of human art; and while by the intelligent observation of such remains in the superficial strata, mingling with the fossil evidences of extinct and familiar species of animal life, the link is supplied by which man takes his place in the unbroken chain of creative existence sweeping backward into so remote a past, the evidences of matured art pertaining to periods unrecorded by history supply the later links of the same chain, and reunite the present with all former ages.

The system of primitive archæology which is found applicable to British antiquities, so closely corresponds in all its essential features to that of Europe prior to the era of authentic history, that the purpose of such an abstract as this will be most conveniently accomplished by presenting its leading points as examples of the whole; illustrating these in passing, by the analogous remains discovered in other countries. The evidences we possess of the various acquirements and degrees of civilization of the aborigines of Great Britain are derived from their ancient dwellings and sepulchres, from cromlechs, barrows, and cairns, and from the weapons, implements, personal ornaments, and pottery found inclosed in these. Valuable additions to our information are also supplied by means of such chance discoveries as agricultural, mining, and building operations frequently lead to; such as the stranded whales found in the alluvial valley of the Forth, many feet above the level of high water, and distant several miles from the present bed of the river. Along with these gigantic cetacean remains lay the proofs of contemporaneous population in the rude harpoons made of deer's horn; while the historical evidence relating to the locality, as well as the distinct remains of Roman military roads, combine to prove the era of local upheaval, apparently indicated by the geological phenomena, to have long preceded the dawn of the period of definite history, or the beginning of the Christian era.

By evidence such as this, a starting point is gained from whence we may confidently deduce the colonization of the British Islands, and of the north of Europe, at a very remote period; certainly many centuries prior to that in which our island first figures in history. The researches of the ethnologist add to our knowledge of this unrecorded period, by disclosing some of the physical characteristics of the aboriginal races, derived from the human remains found in the most ancient sepulchres, accompanied by the rudest evidences of art; and the researches of Nillson, Eschricht, and other continental ethnologists, when brought into comparison

with those which have been made in the British Isles, disclose remarkable points of resemblance in cranial conformation essentially different from those of any of the predominant races now inhabiting Europe.

The immense number of weapons and implements of stone already found in this and other countries, since attention has been more generally directed to the subject, proves that the period which they characterize must have been of very long duration. In various of the museums of Britain, and still more in those of Ireland, very large collections of such have been accumulated in a few years, while in the famous Christiansborg palace at Copenhagen the specimens of stone weapons and implements alone number nearly 4000. For the details of those relics, as well as the distinguishing characteristics of the various classes of sepulchres, the weems, or subterranean dwellings, the monolithic and megalithic monuments, &c., of this primitive period, the student who wishes to pursue the subject more minutely, must refer to the works of Hoare, Douglas, Worsaae, Ackerman, Roach Smith, Wright, Wilson, and others, as well as to the journals and transactions of the various archæological societies.

The period to which the whole of those primitive remains must be referred was unquestionably one of complete barbarism; as is sufficiently apparent from its correspondence to that which the intercourse with European voyagers is bringing to a close among the islands of the Pacific. The subterranean dwellings termed weems (Gaelic *Uamhah*, a cave), or "Pict's houses," have been frequently found, apparently in the state in which they must have been abandoned by their original occupants; and from these we learn that their principal aliments must have been shell-fish and crustacea, derived from the neighbouring sea-beach, along with the chance products of the chase. The large accumulations of the common shell-fish of our coasts found in some of these subterranean dwellings is remarkable, though with such remains have also been repeatedly found the stone quern or hand-mill, as well as the ruder corn-crusher or pestle and mortar; supplying the important evidence, that the primitive nomade had not been altogether ignorant of the value of the cereal grains.

The source of change in Britain, and throughout Europe, from this rude state of barbarism, is clearly traceable to the introduction of metals, and the discovery of the art of smelting ores. Gold was probably the earliest metal wrought, both from its attractive appearance, its superficial deposits, and the condition in which it is frequently found rendering its working an easy process. Tin also, in the south of Britain, was wrought at the very dawn of history; and, with the copper which abounds in the same district of country, supplied the elements of the new and important compound metal, bronze.

It was long assumed by all historians and antiquaries, that the beautiful bronze swords, spear-heads, shields, torques, armillæ, &c., so frequently discovered, were mere relics of foreign conquest or barter; and they were variously assigned to Egyptian, Phœnician, Roman, or Danish origin. But this gratuitous assumption has been disproved by the repeated discovery of the moulds for making such, as well as of the refuse castings, and even of beds of charcoal, scoriæ, and other indications of metallurgy, on the sites where they have been found. It has not escaped notice, however, that the transition appears to be an abrupt one from stone to bronze, an alloy requiring skill and experience for its use; and that few examples are recorded of the discovery of copper tools or weapons, though copper is a metal so easily wrought as to have been in use among the Red Indians of America. The inference from this fact, is one which all elements of probability tend to confirm, viz., that the metallurgic arts of the north of Europe are derived from a foreign source, whether by conquest or traffic, and that in the beautiful bronze relics so abundant, especially in the British Islands and in Denmark, we see the fruits of that experience which the more ancient civilization of Egypt and Phœnicia had diffused. The direct intercourse between the countries on the Mediterranean, and the Cassiterides, or Tin Islands,—as the only known parts of the British Islands are called in the earliest allusions which are made to them by Herodotus, Aristotle, and Polybius,—abundantly accounts for the introduction of such knowledge to the native Britons at a very remote period. Phœnician and Carthagenian merchant ships traded to Cornwall, centuries before the white cliffs of Albion were first seen from the Roman war-galleys. Greece, also, not improbably, proved a mediator in this all-important transfer. It has not escaped attention, that the forms of weapons, and especially of the beautiful "leaf-shaped sword," as figured on the most ancient painted Greek vases, closely correspond to the most characteristic relics of the Bronze period in the north of Europe and the British Isles.

During the later Iron Period the era of authentic history begins. There is no room for doubt that, whatever impetus the Roman invasion may have given to the working of the metals in Britain, iron was known prior to the landing of Julius Cæsar. Within this archæological period, however, the examples of Roman art, and the influences of Roman civilization begin to play a prominent part. To this period succeed the Saxon and Scandinavian eras of invasion, with no less characteristic peculiarities of art-workmanship, as well as of sepulchral rites and social usages. In these later periods, definite history comes to the aid of archæological induction, while those intermediate elements of historical re-edification, the inscriptions on stone and metal, and the numismatic series of chronological records, all unite to complete a picture of the past replete with important elements for the historian.

The connection between archæology and geology has been indicated, but that between archæology and ethnology is of much more practical value, and is every day being brought into clearer view. By the investigation of the tombs of ancient races, and the elucidation of their sepulchral rites, remarkable traces of unsuspected national affinities are brought to light; while a still more obvious correspondence of arts in certain stages of society, among races separated alike by time and by space, reveals a uniformity in the operation of certain *human instincts*, when developed under nearly similar circumstances, such as goes far to supply a new argument in proof of the unity of the human race.

The self-evident truths confirmatory of the principles upon which this system of primitive archæology is based, may be thus briefly summed up:—Man, in a savage state, is, to a great extent, an isolated being; co-operation for mutual and remote advantage, except in war and the chase, is scarcely possible, and hence, experience at best but slowly adds to the common stock of knowledge. In this primitive stage of society, the implements and weapons which necessity renders indispensable, are invariably supplied from the sources at hand; and the element of time being of little moment, the rude manufacturer slowly fashions his stone axe or hammer, or his lance of flint, with an expenditure of labour such as, with the appliances of civilization, would suffice for the manufacture of hundreds of such implements.

The discovery of the metallurgic arts, by diminishing labour, and supplying a material more susceptible of varied forms as well as of ornamentation, and also one originating co-operation by means of the new wants it calls into being, inevitably leads to social progress. The new material, moreover, being limited in supply, and found only in a few localities, soon leads to barter, and thence to a regular trade; and thus the first steps towards a division of labour and mutual co-operation are made. So long, however, as the metal is copper or bronze, the limited supply must greatly restrict

this social progress, while the facilities for working it admit of that isolation so natural to man in a rude state; and these, added to the frequent discovery of copper, in its natural condition much more nearly resembling a ductile metal than the ironstone, abundantly account for its use having preceded that of the more abundant metal.

Great experience must have been acquired in the earlier metallurgy before the iron ore was attempted to be wrought. In this, co-operation was indispensable; but that once secured, and the first difficulties overcome, the other results appear inevitable. The supply is unbounded, widely diffused, and procurable without excessive labour. The material elements of civilization were thereby acquired, and all succeeding progress might be said to depend on the capacity of the race.

The process of research and inductive reasoning thus applied by the archæologist to the traces of primitive art, and the dawn of civilization, as well as to the remains of classic art, is no less applicable to all periods. The songs and legends of the peasantry, the half-obliterated traces of ancient manners, the fragments of older languages, the relics of obsolete art,—all these are parts of what has been fitly styled "unwritten history," and furnish the means of recovering many records of past periods, which must remain for ever a blank to those who will recognize none but written or monumental evidence.

Proceeding to the investigation of this later, and, in most of the higher requirements of history, this more important branch of historical evidence, the archæologist has still his own special departments of investigation. Tracing the various alphabets in their gradual development, through Phœnician, Greek, Roman, and other sources, and the changing forms which followed under the influences of Byzantine and medieval art, a complete system of palæography, has been deduced, calculated to prove an important auxiliary in the investigation of monumental and written documents. Palæography has its own rules of criticism, supplying an element of chronological classification altogether independent of style in works of art, or of internal evidence in graven or written inscriptions, and a test of genuineness often invaluable to the historian.

Heraldry is another element of criticism by which archæology provides trustworthy canons of criticism in relation to written and unwritten medieval records. The seals and matrices, sepulchral sculptures, and engraved brasses, along with an extensive class of the decorations of ecclesiastical and domestic architecture, all supply evidence by means of which names and dates, with confirmatory collateral evidence of various kinds, are frequently recoverable. From the same sources also the changing costume of successive periods can be traced, and thus a new light be thrown on the manners and customs of past ages. The enthusiastic devotee is indeed apt at times to attach an undue importance to such auxiliary branches of study, but it is a still greater excess to pronounce them valueless, and to reject the useful aids they are capable of affording.

No less important are the illustrations of history, and the guides in the right course of research, which numismatics supply, both in relation to early and medieval times. But on this and other sections into which the study of antiquities is divided, the requisite information will be found under the several heads of research. On many of these points the historian and the archæologist necessarily occupy the same field; and, indeed, when that primitive period wherein archæology deals with the whole elements of our knowledge regarding it, as a branch of inductive science and not of critical history, is past, the student of antiquities becomes to a great extent the pioneer of the historian. He deals with the raw materials: the charters, deeds, wills, grants of land, of privileges or immunities, the royal, monastic, and baronial accounts of expenditure, and the like trustworthy documents; by means of their palæography, seals, illuminations, and other evidence, he fixes their dates, traces out the genealogical relationships of their authors, and in various ways prepares and sifts the evidence which is to be employed anew by the historian in revivifying the past. Architecture and all departments of the fine arts, in like manner, supply much evidence which, when investigated and systematized by a similar process, adds valuable materials to the stock of the historian, and furnishes new sources for the illumination of former ages. Such is a sketch of the comprehensive investigations embraced under the name of archæology, which, carried on by many independent labourers, and in widely varied fields of research, have contributed important chapters to the book of human history, and revivified ages long buried in oblivion, or at best but dimly seen through distorting media of myth and fable. (D. W—N.)

ARCHAISM, (from ἀρχαῖος, ancient), the use of an antiquated word or form of expression.

ARCHANGEL, an angel occupying an exalted rank among the spiritual intelligences. The Jewish writers place the archangels in the eighth rank of the celestial hierarchy.

ARCHANGEL, a government of European Russia, lying between Lat. 61. and 71. N. and Long. 29. and 68. E. It is bounded on the north by the White Sea and Arctic Ocean, on the west by Finland and Olonetz, on the south by Vologda, and on the east by the Ural Mountains. It comprehends also the islands of Nova-Zembla, Waigatz, and some others. Its area is estimated at 322,500 square miles, and its population in 1846 was calculated to amount to 253,000. The climate is for most part of the year intensely cold. That part of Archangel which lies within the arctic circle has a very desolate and sterile aspect, presenting little to the eye but extensive plains of sand and moss. The winter is long and severe; and even in summer the soil is frozen at a little depth below the surface. The rivers are closed in September, and scarcely thawed before July. South of the arctic circle the greater part is covered with immense forests, part with extensive lakes and morasses, and part affords excellent pasturage for cattle. Here the spring is moist, with cold, frosty nights; the summer, a succession of long foggy days; the autumn moist; and the rivers are closed from October to April. The northern districts are incapable of being cultivated, and the inhabitants support themselves by fishing and the chase. In the southern districts considerable quantities of hemp and flax are raised, but grain crops are little attended to, and the bark of trees is mixed with corn to eke out the scanty products of the harvest. The principal wealth of the government consists in its immense forests, that furnish materials for ship-building, which is carried on to a considerable extent. Their horses and cattle are diminutive, except in the district of Kholmogory, where excellent cattle are reared. The preparation of pitch and tar is an active branch of industry; and in the districts around Archangel coarse linens are manufactured to a considerable extent, as well as cordage, mats, leather, tallow, turpentine, and potash. This government is divided into eight circles, viz.:—Archangel, Chenkursk, Mezen, Cola, Onega, Pinega, Kholmogory, and Kem. Its chief rivers are the Onega, Pinega, Dwina, Mezen, Petshora, and Ousa. The population was originally Finnish, but it is now chiefly Russian, with some Samoides and Laplanders.

ARCHANGEL, a city of Russia, capital of the government and circle of the same name. It is situated on the right bank of the river Dwina, 35 miles from its mouth, in Lat. 64. 32. 8. N. Long. 40. 33. E. The entrance to the Dwina was discovered by the English navigator Richard Chancellor in 1553, when in quest of a north-eastern passage to China. The city of Archangel was founded in 1584, and derived its name from the convent of St Michael the

Archangel. It soon became the first trading port of Russia, and continued to be so till the rise of St Petersburg, when its commercial importance declined. In 1762 it received the same immunities as St Petersburg; and since that time it has been gradually recovering its former prosperity. Except the bazaar, which is an immense edifice, its buildings are almost entirely constructed of wood. It is the seat of an archbishop, and of a civil and military governor; has one Protestant and ten Greek churches; an ecclesiastical seminary with nine professors; a gymnasium; academies for navigation and engineering; and a naval hospital. The manufactures consist of linen, leather, canvass, cordage, mats, and sugar, and there are several breweries. Archangel is indebted for its prosperity principally to its situation on the Dwina, which is united by canals with the Volga on the one side, and with the Neva on the other, by which means it is the mart of a large extent of territory, some articles being transported thither even from Siberia. Its traffic varies considerably in different years, being much influenced by the demand for corn in England and other parts of Europe. Its principal exports are grain, flax, hemp, timber, linseed, iron, mats, tar, and tallow: its imports are chiefly colonial produce, woollens, cottons, and hardware. In 1847, the value of its exports was L.1,410,880. The value of its imports is always much less than that of its exports. Its harbour is at the island of Solembolsk, about a mile below the town, and is open only from July to September. A bar at the mouth of the Dwina, with only from 13 to 14½ feet of water, obliges vessels of greater draught to load and unload by means of lighters outside the bar. About twelve miles below the town, there is a government dockyard with slips for building vessels, and also some warehouses belonging to merchants in the city. The best season of their year is from the middle of July to the middle of August, before which time fogs and high winds prevail. After that period the nights become cold; and in September it is usually very stormy. There the shortest day has only 3 hours 12 minutes, the longest 21 hours 48 minutes.

ARCHBISHOP, the name of a church dignitary of the first class. Archbishops were not known in the East till about the year 320; and though there were some soon after this who had the title, yet that was only a personal honour, by which the bishops of considerable cities were distinguished. It was not till of late that archbishops became metropolitans, and had suffragans under them. Athanasius appears to be the first who used the title *Archbishop*, which he gave occasionally to his predecessor; Gregory Nazianzen, in like manner, gave it to Athanasius; not that either of them was entitled to any jurisdiction, or even any precedence, in virtue of it. Among the Latins, Isidore Hispalensis is the first that speaks of archbishops. He distinguishes four orders or degrees in the ecclesiastical hierarchy, viz., patriarchs, archbishops, metropolitans, and bishops.

The archbishop, besides the inspection of the bishops and inferior clergy in the province over which he presides, exercises episcopal jurisdiction in his own diocese. He is guardian of the spiritualities of any vacant see in his province, as the king is of the temporalities, and exercises ecclesiastical jurisdiction in it. He is entitled to present by lapse to all the ecclesiastical livings in the disposal of his diocesan bishop, if not filled within six months. Upon consecrating a bishop, he was authorized to name a clerk or chaplain, to be provided for by such bishop; in lieu of which it is now usual to accept an option. He is said to be enthroned when vested in the archbishopric, whereas bishops are said to be installed.

The ecclesiastical government of England is divided into two provinces, viz., Canterbury and York. Canterbury has the following suffragan bishoprics appertaining to it; St Asaph, Bangor, Bath and Wells, Bristol, Chichester, Lichfield and Coventry, St Davids, Ely, Exeter, Gloucester, Hereford, Llandaff, Lincoln, London, Norwich, Oxford, Peterborough, Rochester, Salisbury, Winchester, and Worcester. To York appertain the bishoprics of Carlisle, Chester, Durham, Ripon, and Manchester; to which may be added the bishopric of Sodor and Man, whose bishop is not a lord of parliament.

Till the year 1152, the archbishop of Canterbury had jurisdiction over Ireland as well as England, and was styled a *patriarch*, and sometimes *alterius orbis papa*, and *orbis Britannici pontifex*. Matters were done and recorded in his name thus,—*Anno pontificatus nostri primo*, &c. The first archbishop of Canterbury was Austin, appointed by King Ethelbert on his conversion to Christianity, about the year 598. He was also *legatus natus*. He even enjoyed some special marks of royalty; as to be patron of a bishopric, which he was of Rochester; and to make knights, coin moneys, &c. The archbishop is still the first peer of England, and the next to the royal family, having precedence of all dukes and all great officers of the crown. It is his privilege, by custom, to crown the kings and queens of this kingdom. He may retain and qualify eight chaplains, whereas a duke is allowed by statute only six. He has by common law, the power of probate of wills and testaments, and granting letters of administration. He may also grant licenses and dispensations in all cases formerly sued for in the court of Rome, and not repugnant to the law of God. He accordingly issues special licenses to marry, to hold two livings, &c., and he exercises the right of conferring degrees. He also holds several courts of judicature; as court of arches, court of audience, prerogative court, and court of peculiars.

The archbishop of York has the like rights in his province as the archbishop of Canterbury. He has precedence of all dukes not of the royal blood, and of all officers of state except the lord high chancellor. He has also the rights of a count palatine over Hexhamshire. The first archbishop of York was Paulinus, appointed by Pope Gregory about the year 622. He had formerly jurisdiction over all the bishops of Scotland; but in the year 1470 Pope Sextus IV. created the bishop of St Andrews archbishop and metropolitan of all Scotland.

Scotland, whilst episcopacy prevailed in that country, had two archbishoprics, St Andrews and Glasgow, the former of which was accounted the metropolitan, and, even before it arrived at the dignity of an archbishopric, resisted with great spirit all the attempts of the archbishops of York in England to become the metropolitans of Scotland. The sees of Argyll, Galloway, and the Isles, were suffragans to Glasgow; all the others in the kingdom to St Andrews.

Before the passing of 3d and 4th William IV., c. 37, and 4th and 5th William IV., c. 90, Ireland had four archbishoprics, viz., Armagh, Dublin, Cashel, and Tuam. By these statutes they were reduced to two, Armagh and Dublin, the diocese of Tuam being united to that of Armagh, and th diocese of Cashel to that of Dublin. The archbishop of Armagh is primate of all Ireland.

ARCHCHAMBERLAIN, an officer of the German empire, much the same with the great chamberlain in England. The elector of Brandenburg was appointed by the golden bull archchamberlain of the empire.

ARCHCHANCELLOR, a high officer, who in ancient times presided over the secretaries of the court. Under the first two races of the kings of France, when their territories were divided into Germany, Italy, and Arles, there were three archchancellors; and hence the three archchancellors formerly in Germany—who were the archbishops of Mentz, Cologne, and Treves.

ARCHDEACON, an ecclesiastical dignitary or officer, next to a bishop, whose jurisdiction extends either over the

whole diocese or only a part of it. Archdeacons are appointed by their respective bishops, and by § 27, 3d and 4th Vict., c. 27, they must have been six full years in priests' orders. Their duty is to visit their archdeaconries from time to time; to see that the churches and chancel are kept in repair, and everything done conformably to the canons, and to receive from the churchwardens representations of any matters of public scandal.

The visitation of the archdeacon may be held yearly, but is imperative every third year. The income attached to the office is very inconsiderable, but it is generally held by persons who are possessed of benefices and other preferments in the church. There were formerly 60 archdeacons in England and Wales, but by 6th and 7th Will. IV., c. 97, seven new archdeaconries were established.

Archdeacon's Court is the lowest court in the ecclesiastical polity. It is held, in the archdeacon's absence, before a judge appointed by himself, and called his official; and its jurisdiction is sometimes in concurrence with, sometimes in exclusion of, the bishop's court of the diocese. But, by statute 24th Henry VIII., c. 12, there lies an appeal from this court to that of the bishop. By the act of Will. IV., above cited, it is now, however, enacted that all archdeacons throughout England and Wales shall enjoy full and equal jurisdiction within their several archdeaconries.

ARCHDUKE, a title peculiar to the imperial house of Austria, all the sons of which are archdukes, and the daughters archduchesses.

ARCHELAUS, a celebrated Greek philosopher, born probably at Miletus about 470 B.C. He succeeded his master Anaxagoras in the school which he had founded at Lampsacus, from whence he afterwards removed to Athens. He was the last representative of the Ionian school, between which and the more practical philosophy that followed, his teaching formed a link of transition. His speculations were chiefly, but not exclusively physical, on which account he received the name of the *Physician* (ὁ φυσικός), in contradistinction to his contemporaries the Sophists, and his illustrious disciple Socrates. His opinions were, for the most part reproductions of the ideas of Anaxagoras. The following are some of the peculiar physical doctrines ascribed to him. He taught that there was a double principle of all things, namely, the *expansion* and *condensation* of the air, which he regarded as infinite. Heat, according to him, was in continual motion; cold was ever at rest. The earth, which was placed in the midst of the universe, had no motion. It originally resembled a wet marsh, but was afterwards dried up; and its figure, he said, was not flat but spherical, which he deduced from the fact that the sun does not become visible at the same time in all places. The sea he regarded as the overflowing of the waters contained within the earth. Animals were produced from the heat of the earth, and even men were formed in the same manner. All animals have a soul, which was born with them, but the capacities of which vary according to the structure of the organs of the body in which it resides. In morals he showed his approximation to the Sophists, by teaching that right and wrong are founded not in nature but on custom.

ARCHELAUS, king of Macedonia, was the natural son of Perdiccas, and ascended the throne after murdering his younger brother, the legitimate heir. His bloody usurpation, however, was followed by a reign devoted to the improvement of his kingdom and the patronage of the fine arts. He was assassinated B.C. 400 by one of his courtiers.

ARCHELAUS, the son of Herod the Great, was declared king of Judæa the second year after the birth of Christ. The dispute with his brother Antipas regarding the succession was referred to the decision of Augustus, who awarded to Archelaus half his father's territory. His brief reign was marked by great cruelty; as an instance of which is recorded his putting to death 3000 persons who had been concerned in a religious outbreak. On fresh complaints exhibited against him by the Jews, Augustus banished him to Vienne in Gaul, A.D. 6, where he died.

ARCHELAUS, the opponent of Sylla, in his wars against Mithridates. He afterwards went over to the Romans, who respected his military talents.

ARCHELAUS, the son of Apollonius, one of the greatest sculptors of antiquity, was a native of Ionia, and is thought to have lived in the time of the Emperor Claudius. He executed in marble the apotheosis of Homer. Kircher, Spanheim, and several other learned antiquaries have given a description of his work. It is now in the British Museum, having been purchased in 1819 for L.1000.

ARCHENA, a town of Murcia, in Spain. It is situated on the river Segura, at the eastern extremity of the delicious valley of Ricote, and is celebrated for its thermal springs. The waters retain a uniform heat of 112° Fahr. These springs are much resorted to, though the situation is most melancholy, and the accommodation for invalids very bad.

ARCHENHOLZ, JOHANN WILHELM VON, is best known by his "History of the Seven-Years-War," and "Life of Gustaf Vasa." Both are works of high authority. He likewise wrote a work on "England and Italy," which was also well received. He was born at Danzig in 1745, and died in 1812.

ARCHERY, the art or exercise of shooting with a bow and arrow. The word is formed of *arcus*, a bow; whence *arcuarius*, and even *arquis* and *arquites*, as they are also denominated in the corrupt state of the Latin tongue. The bow was anciently one of the principal implements of war, and the expertness of the archers often decided the fate of battles and of empires. In this island archery was greatly encouraged in former times, many statutes being made for its advancement; and the English archers became the best in Europe.

The *Artillery Company* of London, though they have long disused the weapon, are the remains of the ancient fraternity of bowmen or archers. Artillery (*artillérie*) is a French term signifying *archery*, as the *king's bowyer* is in that language styled *artillier du roy;* and from that nation the English seem to have learnt at least the cross-bow archery. We therefore find that William the Conqueror had a considerable number of bowmen in his army at the battle of Hastings, when no mention is made of such troops on the side of Harold; and it is supposed that these Norman archers shot with the arbalest or cross-bow, in which formerly the arrow, termed in French a *quadrel*, and in English a *bolt*, was placed in a groove.

Archæologia, vol. vi.

Of the time when shooting with the long-bow first began among the English, at which exercise they afterwards became so expert, there appear no certain accounts. Their chronicles do not mention the use of archery as expressly applied to the cross-bow or the long-bow till the death of Richard I., who was killed by an arrow at the siege of Limoges in Guienne, which Hemmingford mentions as having issued from a cross-bow. After this event, which happened in 1199, there appear not upon record any notices of archery for nearly 150 years, when an order was issued by Edward III., in the 15th year of his reign, to the sheriffs of most of the English counties, for providing 500 white bows and 500 bundles of arrows, for the intended war against France. Similar orders are repeated in the following years; with this difference only, that the sheriff of Gloucestershire is directed to furnish 500 painted bows, as well as the same number of white. In the famous battle of Cressy, which was fought in the year 1346, our chroniclers state that we had 2800 archers, who were opposed to about the same number of the French. The statement that the bows of the French, or rather their strings, were damaged by a shower of rain which

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fell a short time before the engagement, seems to prove that by this time we used the long-bow, while the French archers shot with the arbalest; for the long-bow, when unstrung, may be conveniently covered, so as to prevent the rain's injuring it; whereas, from the form of the arbalest it cannot be conveniently sheltered from the weather.

At the above-mentioned battle the English ascribed their victory chiefly to the archers. The battle of Poictiers was fought in 1356, and gained by the same means.

Sometimes the archers obtained great victories without even the least assistance from the men-at-arms; as particularly the decisive victory over the Scots at Homildon in 1402. In that bloody battle the men-at-arms did not strike a stroke, but were mere spectators of the valour and victory of the archers. The French historian, Philip de Comines, agrees with our own writers in asserting that the English archers excelled those of every other nation; and Sir John Fortescue says again and again, "that the might of the realme of England standyth upon archers." The superior dexterity of their archers gave the English a great advantage over both the French and the Scots. The French depended chiefly on their men-at-arms, and the Scots on their pikemen; but the ranks of both were often thinned and thrown into disorder by flights of arrows before they could reach their enemies.

Henry's *Hist.* vol. v. p. 463.

James I. of Scotland, who had seen and admired the dexterity of the English archers, and who was himself an excellent archer, endeavoured to revive the exercise of archery among his own subjects, by whom it had been too much neglected. With this view he procured the following law to be made in his first parliament, in 1424, immediately after his return to Scotland: "That all men might busk thame to be archares fra the be 12 years of age; and that at ilk ten punds worth of land thair be made bow markes, and speciallie near paroche kirks, quhairn upon halie dayis men may cum, and at the leist schute thryse about, and have usage of archarie; and whasa usis not archarie, the laird of the land sal rais of him a wedder; and giff the laird raisis not the said pane, the king's shiref, or his ministers, sal rais it to the king." But his death prevented the effectual execution of this law.

There is no act of parliament of Henry V. in relation to archery, and all the orders of Rymer till the battle of Agincourt relate to great guns, from which he seems at first to have expected more considerable advantage than from the training of bowmen. This sort of artillery, however, from its unwieldiness, from bad and narrow roads, and from other causes, was as yet but of little use in military operations. This king therefore ascribes his victory at Agincourt to the archers, and directs the sheriffs of many counties to pluck from every goose six wing-feathers for the purpose of improving arrows, which are to be paid for by the king.

In 1421, though the French had been defeated both at Cressy, Poictiers, and Agincourt, by the English archers, yet they still continued the use of the cross-bow; for which reason Henry V., as duke of Normandy, confirms the charters and privileges of the balistarii, who had been long established as a fraternity in his city of Rouen.

In the fifth of Edward IV. an act passed, that every Englishman, and Irishman dwelling with Englishmen, shall have an English bow of his own height, which is directed to be made of yew, wych, hazel, ash, or awburne, or any other reasonable tree, according to their power. The next chapter also directs that butts shall be made in every township, which the inhabitants are obliged to shoot up and down every feast day, under the penalty of a halfpenny when they shall omit this exercise.

In the 14th year, however, of this same king, it appears by Rymer's *Fœdera*, that 1000 archers were to be sent to the duke of Burgundy, whose pay is settled at sixpence a day, which was a considerable sum in those times, when the value of money was so much higher than it is at present. This circumstance seems to prove very strongly the great estimation in which archers were still held. In the same year Edward, preparing for a war with France, directs the sheriffs to procure bows and arrows, "as most specially requisite and necessary."

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On the war taking place with Scotland, eight years after this, Edward provides both ordnance and archers; so that though the use of *artillery*, as we now term it, was then gaining ground, yet that of the bow and arrow was not neglected.

Richard III., by his attention to archery, was able to send 1000 bowmen to the duke of Bretagne; and he availed himself of the same troops at the battle of Bosworth.

During the reign of Henry VII., however, there appears no order relative to gunpowder or artillery; while, on the other hand, in 1488, he directs a large levy of archers to be sent to Brittany, and that they shall be reviewed before they embark. In the 19th year of his reign, the same king forbids the use of the cross-bow, because "the long-bow had been much used in this realm, whereby honour and victory had been gotten against outward enemies, the realm greatly defended, and much more the dread of all Christian princes, by reason of the same."

During the reign of Henry VIII. several statutes were made for the promotion of archery. The 8th Eliz. c. 10, regulates the price of bows; and the 13th Eliz. c. 14, enacts that bow-staves shall be brought into the realm from the Hans Towns and the eastward; so that archery still continued to be an object of attention in the legislature.

In Rymer's *Fœdera* there is neither statute nor proclamation of James I. on this head; but it appears, by Dr Birch's life of his son (Prince Henry), that at eight years of age he learned to shoot both with the bow and gun, while at the same time this prince had in his establishment an officer who was styled *bow-bearer*. The king granted a second charter to the Artillery Company, by which the powers they had received from Henry VIII. were considerably extended.

Charles I. appears, from the dedication of a treatise entitled *The Bowman's Glory*, to have been himself an archer; and in the eighth year of his reign he issued a commission to the chancellor, lord mayor, and several of the privy council, to prevent the fields near London being so inclosed as to "interrupt the necessary and profitable exercise of shooting;" as also to lower the mounds where they prevented the view from one mark to another.

Catharine of Portugal, queen to Charles II., seems to have been much pleased with the sight at least of this exercise; for in 1676, by the contributions of Sir Edward Hungerford and others, a silver badge for the marshal of the fraternity was made, weighing 25 ounces, and representing an archer drawing the long-bow (in the proper manner) to his ear, with the following inscription: *Reginæ Catharinæ Sagittarii.* The supporters are two bowmen, with the arms of England and Portugal. In 1682 there was a most magnificent cavalcade and entertainment given by the Finsbury archers, when they bestowed the titles of "Duke of Shoreditch," "Marquis of Islington," &c. upon the most deserving. Charles II. was present upon this occasion.

So late as the year 1753 targets were erected in the Finsbury fields during the Easter and Whitsun holydays, when the best shooter was styled captain for the ensuing year, and the second lieutenant.

Before the introduction of fire-arms the enemy could only be struck at a distance by slings, the bow used by the ancients, or the cross-bow; to all which the English long-bow was infinitely superior. As for slings, they never have been used in the more northern parts of Eu-

rope by armies in the field; nor does their use indeed seem to have been at all convenient or extensively practicable, for two principal reasons: in the first place, slingers cannot advance in a compact body, on account of the space to be occupied by this weapon in its rotatory motion; in the next place, the weight of the stones to be carried must necessarily impede the slingers greatly in their movements. The bow of the ancients, again, as represented in all their reliefs, was a mere toy compared with that of our ancestors; it was therefore chiefly used by the Parthians, whose attacks, like those of the present Arabs, were desultory. As for the cross-bow, it is of a most inconvenient form for carriage, even with the modern improvements; and, in case of rain, could not easily be secured from the weather. After the first shot, moreover, it could not be recharged under a considerable time, whilst the bolts were also heavy and cumbersome. The English long-bow, on the other hand, together with the quiver of arrows, was easily carried by the archer, as easily secured from the rain, and recharged almost instantaneously. It is not therefore extraordinary, that troops who solely used this most effectual weapon should generally obtain the victory, even when opposed to much more numerous armies.

It may be urged, that these losses having been experienced by our enemies, must have induced them to practise the same mode of warfare. But it is thought that the long-bow was not commonly used even in England till the time of Edward III., when the victory at Cressy sufficiently proclaimed the superiority of that weapon. It required, however, so much training before the archer could be expert, that we must not be surprised if, soon afterwards, this military exercise was much neglected, as appears by the preambles of several ancient statutes. While the military tenures subsisted, the sovereign could only call upon his tenants during war, who therefore attended with the weapons they had been used to, and which required no previous practice. On the other hand, the English archers were obliged by acts of parliament, even in time of peace, to erect butts in every parish, and to shoot on every Sunday and holyday, after repairing perhaps to these butts from a considerable distance; while the expense of at least a yew bow is represented as being a charge to which they were scarcely equal. The kings and parliaments of this country having thus compelled the inhabitants to such training, the English armies had, it should seem, the same advantage over their enemies as the exclusive use of fire-arms would give us at present.

It appears, also, by what has been already stated, that the long-bow continued to be in estimation for more than two centuries after gunpowder was introduced, which probably arose from muskets being very cumbersome and unwieldy. It is well known that rapid movements are generally decisive of the campaign; and for such the archers were particularly adapted, because, as they could not be annoyed at the same distance by the weapons of the enemy, they had scarcely any occasion for armour. The flower of ancient armies likewise was the cavalry, against which the long-bow never failed to prevail; and hence the great number of French nobility who were prisoners at Cressy, Poictiers, and Agincourt; for being dismounted, if not wounded, whilst they were also clad in heavy armour, they could not make their escape. The same reason accounts for the English obtaining these signal victories with so inferior numbers; for the nobility and gentry thus becoming prisoners, the other parts of the French army made little or no resistance. No wonder, therefore, that in England the greatest anxiety was shown to promote the exercise of this most important weapon, and that so many statutes were made for that purpose.

In Scotland, also, little less attention, though apparently not with equal success, was shown to the encouragement of the art. In both kingdoms it was provided that the importers of merchandise should be obliged, along with their articles of commerce, to import a certain proportion of bows, bow-staves, and shafts for arrows. In both every person was enjoined to hold himself provided in bows and arrows, and was prescribed the frequent use of archery. In both a restraint was imposed upon the exercise of other games and sports, lest they should interfere with the use of the bow; for it was intended that people should be made expert in the use of it as a military weapon, by habituating them to the familiar exercise of it as an instrument of amusement. As there was no material difference between the activity and bodily strength of the two people, it might be supposed that the English and Scots wielded the bow with no unequal vigour and dexterity; but, from undoubted historical monuments, it appears that the former had the superiority, of which one instance has been already narrated. By the regulations prescribed in their statute-book for the practice of archery, we find that the English shot a very long bow, those who were arrived at their full growth and maturity being prohibited from shooting at any mark that was not distant upwards of 220 yards.

In the use of the bow, great dexterity as well as strength seems to have been requisite. Though we hear of arrows at Chevy Chase which were a yard long, yet it is by no means to be supposed that the whole band made use of such, or could draw them to the head. The regulation of the Irish statute of Edward IV., viz. that the bow should not exceed the height of the man, is allowed by archers to have been well considered; and as the arrow should be half the length of the bow, this would give an arrow of a yard in length to those only who were six feet high. A strong man of this size in the present times cannot easily draw above 27 inches, if the bow is of a proper strength to do execution at a considerable distance. At the same time it must be admitted, that as our ancestors were obliged by some of the old statutes to begin shooting with the long-bow at the age of seven, they might have acquired a greater sleight in this exercise than their descendants, though the latter should be allowed to be of equal strength.

As the shooting with the long-bow was first introduced in England, and practised almost exclusively for nearly two centuries, so it has occasioned a peculiar method of drawing the arrow to the ear and not to the breast. That this is contrary to the usage of the ancients is very clear from their reliefs, and from the tradition of the Amazons cutting off one of their paps, as it occasioned an impediment to their shooting. The Finsbury archer is therefore represented in this attitude of drawing to the ear, both in the *Bowman's Glory* and in the silver badge given by Catharine to the Artillery Company.

As to the distance to which an arrow can be shot from a long-bow with the best elevation of 45 degrees, that must necessarily depend much both upon the strength and sleight of the archer; but in general the distance was reckoned from eleven to twelve score yards. The butts for exercise, as above noticed, were directed to be distant upwards of 220 yards. There is indeed a tradition, that an attorney of Wigan in Lancashire, named Leigh, shot a mile in three flights; but the same tradition states that he placed himself in a very particular attitude, which cannot be used commonly in this exercise. According to Neade, an archer might shoot six arrows in the time of charging and discharging one musket.

The archers consider an arrow of from 20 to 24 drop weight to be the best for flight or hitting a mark at a con-

siderable distance, and that yew is the best material of which they can be made. As to the feathers, that of a goose is preferred: it is also wished that the bird should be two or three years old, and that the feather may drop of itself. Two out of three feathers in an arrow are commonly white, being plucked from the gander; but the third is generally brown or gray, being taken from the goose, and, from this difference in point of colour, informs the archer when the arrow is properly placed. From this most distinguished part, therefore, the whole arrow sometimes receives its name: and this, by the by, affords an explanation of the gray-goose wing in the ballad of Chevy Chase. Arrows were armed anciently with flint or metal heads, latterly with heads of iron: of these there were various forms and denominations. By an act of parliament made the 7th of Henry IV. it was enacted, That for the future all the heads for arrows and quarrels should be well boiled or brased, and hardened at the points with steel; and that every arrow-head or quarrel should have the mark of the maker: workmen disobeying this order were to be fined and imprisoned at the king's will, and the arrow-heads or quarrels to be forfeited to the crown.

Grose *on Ancient Armour.*

Arrows were reckoned by sheaves, a sheaf consisting of 24 arrows. They were carried in a quiver, called also an *arrow-case*, which served for the magazine; arrows for immediate use were worn in the girdle. In ancient times phials of quicklime, or rather combustible matter, for burning houses or ships, were fixed on the heads of arrows, and shot from long-bows. This has been also practised since the use of gunpowder. Neade says he has known by experience that an archer may shoot an ounce of fireworks upon an arrow twelve score yards. Arrows with wildfire, and arrows for fireworks, are mentioned among the stores at Newhaven and Berwick in the 1st of Edward VI.

The force with which an arrow strikes an object at a moderate distance may be conceived from the account given by King Edward VI. in his journal; wherein he says, that 100 archers of his guard shot before him two arrows each, and afterwards altogether; and that they shot at an inch board, which some pierced quite through and struck into the other board; divers pierced it quite through with the heads of their arrows, the board being well-seasoned timber: their distance from the mark is not mentioned.

To protect our archers from the attacks of the enemy's horse, they carried long stakes pointed at both ends: these they planted in the earth, sloping before them. In the first of Edward VI., 350 of these were in the stores of the town of Berwick, under the article of archers' stakes: there were also at the same time eight bundles of archers' stakes in Pontefract castle.

To prevent the bowstring from striking the left arm, the arm is covered with a piece of smooth leather, fastened on the outside of the arm—this is called a *bracer;* and to guard the fingers from being cut by the bowstring, archers wore shooting gloves. Chaucer, in his prologue to the Canterbury Tales, thus describes an archer of his day:

And he was cladde in cote and hode of grene.
A shefe of peacock arwes bright and kene
Under his belt he bare ful thriftily.
Wel coude he dresse his takel yemanly:
His arwes drouped not with fetheres lowe.
And in his hond he bare a mighty bowe.
A not-hed hadde he, with a broune visage.
Of wood-craft coude he wel alle the usage.
Upon his arme he bare a gaie bracer,
And by his side a swerd and a bokeler,
And on that other side a gaie daggere,
Harneised wel, and sharpe as point of spere:
A Cristofre on his brest of silver shene.
An horne he bare, the baudrik was of grene.
A forster was he sothely as I gesse.

Though archery continued to be encouraged by the king and legislature for more than two centuries after the first knowledge of the effects of gunpowder, yet by the latter end of the reign of Henry VIII. it seems to have been partly considered as a pastime. Arthur, the elder brother of Henry, is said to have been fond of this exercise, insomuch that a good shooter was styled Prince Arthur. We are also informed that he pitched his tent at Mile-End in order to be present at this recreation, and that Henry his brother also attended. When the latter afterwards became king, he gave a prize at Windsor to those who should excel in this exercise; and a capital shot having been made, Henry said to Barlow (one of his guards), "If you still win, you shall be duke over all archers." Barlow therefore having succeeded, and living in Shoreditch, was created duke thereof. Upon another occasion Henry and the queen were met by 200 archers on Shooter's hill, which probably took its name from their assembling near it to shoot at marks. This king likewise gave the first charter to the Artillery Company, in the 29th year of his reign, by which they are permitted to wear dresses of any colour except purple and scarlet—to shoot not only at marks, but birds, if not pheasants or herons, and within two miles of the royal palaces. They are also enjoined by the same charter not to wear furs of a greater price than those of the marten. The most material privilege, however, is that of indemnification for murder, if any person passing between the shooter and the mark is killed, provided the archers have first called out *fast.*

The following description of an archer, his bow, and accoutrements, is given in a MS. written in the time of Queen Elizabeth. "Captains and officers should be skilful of that most noble weapon, and to see that their soldiers according to their draught and strength have good bowes, well nocked, well strynged, every strynge whippe in their nocke, and in the myddes rubbed with wax, braser and shuting glove, some spare strynges trymed as aforesaid, every man one shefe of arrows, with a case of leather defensible against the rayne, and in the same fower and twentie arrowes, whereof eight of them should be lighter than the residue, to gall or astoyne the enemye with the hailshot of light arrows, before they shall come within the danger of the harquebuss shot. Let every man have a brigandine, or a little cote of plate, a skull or hufkyn, a mawle of leade of five foote in lengthe, and a pike, and the same hanging by his girdle, with a hook and a dagger; being thus furnished, teach them by musters to marche, shoote, and retire, keepinge their faces upon the enemy's. Sumtyme put them into great nowmbers, as to battell apparteyneth, and thus use them often times practised, till they be perfecte; ffor those men in battel ne skirmish can not be spared. None other weapon maye compare with the same noble weapon."

The long-bow, as already observed, maintained its place in our armies long after the invention of fire-arms; nor have there been wanting experienced soldiers who were advocates for its continuance, and who in many cases even preferred it to the harquebuss or musket. King Charles I. twice granted special commissions under the great seal for enforcing the use of the long-bow. The first was in the 4th year of his reign; but this was revoked by proclamation four years afterwards, on account of divers extortions and abuses committed under sanction thereof. The second, anno 1633, in the ninth year of his reign, to William Neade and his son, also named William, wherein the former is styled an ancient archer, who had presented to the king a warlike invention for uniting the use of the pike and bow, seen and approved by him and his council of war; whereof his majesty had granted them

a commission to teach and exercise his loving subjects in the said invention, which he particularly recommended the chief officers of his trained bands to learn and practise; and the justices and other chief magistrates throughout England are therein enjoined to use every means in their power to assist Neade, his son, and all persons authorized by them, in the furtherance, propagation, and practice of this useful invention. Both the commissions and proclamation are printed at large in Rymer. At the breaking out of the civil war, the earl of Essex issued a precept, dated in November 1643, for stirring up all well-affected people towards the raising of a company of archers for the service of the king and parliament.

There are several societies of archers in England; but the most noted society of this kind now existing is

The Royal Company of Archers, the King's Body Guard for Scotland. The ancient records of this company having been destroyed by fire about the end of the 16th century, no authentic traces of its institution now remain; but, from entries found in some of the old national records, this company must be of great antiquity. It is believed that the Royal Company owes its origin to the commissioners appointed in the reign of James I. of Scotland for enforcing and overseeing the exercise of archery in different counties. These commissioners, who were men of rank and power, picked out from among the better classes under their cognizance, the most expert bowmen, formed them into a company, and upon perilous occasions they attended the king as his chief body guard; and in that situation they always distinguished themselves for their loyalty, courage, and skill in archery. The rank of King's Body Guard for Scotland was from tradition understood to be vested in the Royal Company, and they accordingly claimed the honour of acting as body guard to his majesty King George IV. on the occasion of his visit to Scotland in 1822. His majesty was graciously pleased to recognise their claim, and the Royal Company were thus established as the King's Body Guard for Scotland. They attended his majesty at court and on all state occasions during his residence in Scotland, and accompanied him on his visit to Hopetoun House, from whence he embarked for London. The captain-general has since been appointed gold stick for Scotland, and the Royal Company now forms part of the household.

It appears from the minutes of the Royal Company now extant, that an act of the privy council of Scotland was passed in 1677, conferring on them the name and title of "His Majesty's Company of Archers," and granting a sum of money for a piece of plate to be shot for in that year as a prize; but no *permanent* king's prize was established until 1788, when his majesty George III., as a mark of his royal patronage and favour, was pleased to grant a sum of money to be shot for annually, to be named the king's prize, and to become the property of the winner. The gainer is bound to purchase a piece of plate, on which must be inscribed the king's arms, and the date when the prize was gained.

During the revolution in 1688 the Royal Company were opposed to the principles then espoused; and for many years they had to forego their public parades, and the company in consequence had nearly been annihilated. On the accession of Queen Anne, however, their former splendour was revived; and in the year 1703 a royal charter was granted, confirming all their former rights and privileges, and conferring others upon them.

Thus the Royal Company continued to flourish for a number of years; but their attachment to the family of Stuart was the cause at various times of a temporary prosperity and decline. These unhappy differences having long since terminated, the Royal Company, which consists of the principal nobility and gentry of Scotland, are now more prosperous, and perhaps more dexterous in the art of archery, than at any former period in their history.

The prizes belonging to this Royal Company, and which are annually shot for, are, 1*st*, A silver arrow, given by the town of Musselburgh, which appears to have been shot for as early as the year 1603. The victor in this, as in the other prizes, except the king's prize, has the custody of it for a year, then returns it with a medal appended, on which are engraved any motto and device which the gainer's fancy dictates. 2*d*, A silver arrow, given by the town of Peebles A. D. 1626. 3*d*, A silver arrow, given by the city of Edinburgh A. D. 1709. 4*th*, A silver arrow, given by the town of Selkirk, which was shot for in 1819, after an interval of 144 years. 5*th*, A silver punch bowl, made of Scotish silver, at the expense of the company A. D. 1720, to which a gold medal has annually been attached. This prize can only be gained by three consecutive ends; and if not won during the summer, it is shot for as an ordinary prize at the end of the season. 6*th*, A gold medal, made of pagodas, being part of the money paid by Tippoo Sultan at the treaty of Seringapatam, and presented to the Royal Company by Major James Spens. 7*th*, An elegant silver vase and gold medal, presented by General John Earl of Hopetoun, in commemoration of the visit of George IV. to Scotland in 1822, called the royal commemoration prize, and which is shot for on the king's birth-day annually. These prizes are all shot for at the distance of 180 yards. There is another prize, which was given by Sir George Mackenzie of Coul, Bart., to the Royal Company, to be shot for at the distance of 200 yards, and is called the "Saint Andrew prize." These prizes are shot for at rovers, and, with the exception of the silver bowl, are gained by the person who counts the greatest number of points in a given number of ends.

Besides the above, there is another prize shot for, at the distance of 100 yards, being an elegant silver bugle-horn, presented to the Royal Company by one of the general officers, Sir Henry Jardine, Knt., and was shot for on 9th April 1830 for the first time.

There are also two prizes contended for at butts, or point blank distance, being 100 feet. The first is called the goose. The ancient manner of shooting for this prize was, by building a living goose in a turf-butt, having the head only exposed to view; and the archer who first hit the head was entitled to have the goose as his reward, and bore the title of Captain Goose for the season. This barbarous custom has long since been laid aside; and in place of the goose's head a small glass globe is put into the butt, of about an inch in diameter, and the archer who breaks this is declared victor, and is entertained by the company at dinner. He wears a medal which was presented by Major Spens, also made of Tippoo Sultan's pagodas. The other butt prize is a gold medal, which is shot for on the last Saturday of January, February, and March, annually, and is gained by him who counts the greatest number of points in the three days shooting.

The affairs of the Royal Company are managed by a council, consisting of seven, who are chosen annually at a general meeting of the members. The council are vested with the power of receiving or rejecting candidates for admission, and of appointing the officers of the company, civil and military.

The Royal Company consists of about 500 members. There are weekly meetings of members at Edinburgh, in the Meadows, when they exercise themselves in shooting at butts and rovers; and in the adjoining ground they have a handsome building called Archer's Hall, erected within these 50 years, where they dine, and hold their elections and other meetings relative to the business of the company.

The field uniform of the Royal Company is of dark-green cloth, faced with black braiding, with a narrow stripe of crimson velvet in the centre. The hat is of the same colour, with a handsome medallion in front, and a plume of black feathers.

The Royal Company have two standards, which are very old. The first of these bears on one side Mars and Venus, encircled in a wreath of thistles, with this motto, "In peace and war." On the other side is a yew-tree, with two men dressed and equipped as archers, encircled as the former; motto, "Dat gloria vires." The other standard displays on one side a lion rampant, gules on a field or, encircled with a wreath; on the top a thistle and crown; motto, "Nemo me impune lacessit." On the reverse side St Andrew on the Cross, on a field argent; at the top a crown; motto, "Dulce pro patria periculum."

His late Majesty King William IV. presented the Royal Company of Archers, his Body Guard for Scotland, with new colours. The one combines both the old ones, with the words, "The Royal Company of Archers;" and the other bears the Royal Arms of Scotland, with the words, "King's Body Guard for Scotland." His Majesty also expressly confirmed the appointment of the Royal Company to be "the King's Body Guard for Scotland."

ARCHES COURT. See COURT OF ARCHES.

ARCHETYPE (ἀρχέτυπος), the original model of a work of art. Among minters it is used for the standard weight by which the others are adjusted. The archetypal world, in the language of Plato, means the world as it existed in the Divine mind before the visible creation.

ARCHEUS (from ἀρχή), a term employed by Basil Valentine, Paracelsus, and Van Helmont, to denote the regulative and conservative principle of the animal world, expressed in modern language by the word *vital force*.

ARCHIACOLYTHUS (from ἀρχός and ἀκόλουθος), the chief of the acolythi. See ACOLYTE.

ARCHIATER (ἀρχίατρος), properly the chief physician of a prince, or a superintendent over subordinate physicians.

ARCHIDAPIFER (from ἀρχός, and *dapifer*), or chief sewer, was a great officer of the empire. This office belonged to the elector of Bavaria, though claimed by the palatine of the Rhine.

ARCHIDONA, a city of Andalucia in Spain, on a small stream which flows into the river Guadalorza, in the province of Granada. It is a well-built town, with one church, five monasteries, the ruins of an extensive Moorish castle, and 7611 inhabitants, chiefly engaged in the manufacture of linen and olive oil.

ARCHIGALLUS, in *Antiquity*, the chief of the Galli, or priests of the goddess Cybele.

ARCHIGERONTES (from ἀρχός, and γέρων, *old*), in *Antiquity*, the chiefs or masters of the several companies of artificers at Alexandria. Some have mistaken the archigerontes for the archpriests appointed to take the confession of those who were condemned to the mines.

ARCHIL, ARCHILLA, ROCELLA, ORSIELLE, is a whitish moss which grows upon rocks, in the Canary and Cape de Verde Islands, and yields a rich purple tincture, fugitive indeed, but extremely beautiful. It is produced from various lichens, *Rocella tinctoria*, *R. lecanora*, *Lichen tartarea*, *L. parella*, *Variolaria orcina*, *V. dealbata*, &c. This weed is imported to us as it is gathered. Those who prepare it for the use of the dyer grind it between stones, so as to thoroughly bruise, but not to reduce it into powder; and then moisten it occasionally with a strong spirit of urine, or urine itself mixed with quicklime. In a few days it acquires a purplish red, and at length a blue colour. In the first it is called *Archil;* in the latter, *Lacmus* or *Litmus*.

ARCHILOCHIAN, a term in poetry applied to the verse of which Archilochus was the inventor; consisting of seven feet, of which the first four are ordinarily dactyles, though sometimes spondees; the last three trochees.

ARCHILOCHUS, a famous Greek poet and musician, was, according to Herodotus, contemporary with Candaules and Gyges, kings of Lydia, who flourished about the 14th Olympiad, 724 years before Christ. He was born at Paros, one of the Cyclades. His father Telesicles was a man of high rank, and was chosen by his countrymen to consult the oracle at Delphi concerning the sending of a colony to Thasos. He is said, however, to have sullied his birth by an ignoble marriage with a slave called *Enipo*, of which alliance our poet-musician was the fruit. Archilochus showed an early genius and attachment to poetry and music; but disgust with his country and the conduct of Lycambes, who had promised him one of his daughters, induced him to emigrate to Thasos. In a battle against the Thracians of the continent, the young poet lost his buckler, though he saved his life by the help of his heels. "It is much easier," said he, "to get a new buckler than a new existence."

According to Plutarch, there was no bard of antiquity by whom the two arts of poetry and music were so much advanced as by Archilochus. To him is attributed particularly the sudden transition from one rhythm to another of a different kind, and the manner of accompanying those irregular measures upon the lyre. Heroic poetry, in hexameter verse, seems to have been solely in use among the more ancient poets and musicians; and the transition from one rhythm to another, which lyric poetry required, was unknown to them; so that if Archilochus were the first author of this mixture, he might with propriety be styled the *Inventor of Lyric Poetry*. To him is likewise ascribed the composition of the first *iambic poetry* in Greece, and the invention of *Epodes*. One of his hymns, written in honour of Hercules, brought him the acclamations of all Greece; for he sung it in full assembly at the Olympic games, and had the satisfaction of receiving from the judges the crown of victory consecrated to real merit. This hymn or ode was afterwards sung in honour of every victor at Olympia who had no poet to celebrate his particular exploits.

Archilochus was slain by one Calondas or Corax, of the island of Naxos; who, though he did it in fight according to the laws of war, was driven out of the temple of Delphi, by command of the oracle, for having deprived of life a man consecrated to the Muses.

The names of Homer and Archilochus were revered and celebrated in Greece, as the two most excellent poets the nation had ever produced. This appears from an epigram in the Anthology; and from Cicero, who ranks Archilochus with poets of the first class, and in his Epistles tells us that the grammarian Aristophanes, the most rigid and scrupulous critic of his time, used to say that the longest poem of Archilochus always appeared to him the most excellent. Some fragments of his poems have been preserved. These may be seen in the *Poetæ Lyrici Græci*, published by Th. Bergk, p. 467–500.

ARCHIMAGUS, the high priest of the Persian Magi or worshippers of fire. Darius Hystaspes took upon himself the dignity of Archimagus; for Porphyry tells us he ordered that after his death, among the other titles, it should be engraven on his monument that he had been *Master of the Magi*. This seems to have been the reason that the kings of Persia were ever afterwards considered to be of the sacerdotal tribe, and were always initiated into the sacred order of the Magi before their coronation.

ARCHIMANDRITE (from μάνδρα, a convent), a name applied in the Greek Church to the superior (or abbot) of a convent, especially of the first order, such as that of Mount Athos. In ancient times it was of wider application, being sometimes applied to archbishops.

ARCHIMEDES, the most celebrated of the ancient ma-

thematicians, was born at Syracuse in Sicily, about the year 287 before the Christian era. Hiero, king of Syracuse, deemed it an honour to have this philosopher for his relative and friend. History does not inform us by whom he was instructed in the rudiments of literature, but he flourished about 50 years after Euclid. It is reported that he was indebted to Egypt for much of his knowledge; but other accounts indicate that he conferred more knowledge than he received from that celebrated nation; and, in particular, Diodorus mentions that Egypt was indebted to him for the invention of the screw-pump for drawing off water: and the same author narrates that he was the inventor of several other useful machines, which conveyed his fame to every quarter of the globe. The following passage from Livy proves that he was celebrated both for the invention of warlike machines, and also for his accurate observation of the heavenly bodies: "Unicus spectator cœli siderumque, mirabilior tamen inventor ac machinator bellicorum tormentorum," &c. lib. xxiv. cap. 34. It appears also that, in Cicero's time, his skill in solving problems had become proverbial. In a letter to Atticus, he informs him that he is now freed from a difficulty, which he termed an Archimedean problem, *Ep.* xiii. 28.

Vitruvius mentions a fact which proves Archimedes's knowledge in the doctrine of specific gravity. Hiero, the king, having given a certain quantity of gold wherewith to make a golden crown, and suspecting that the workmen had stolen part of the gold and substituted silver in its stead, he applied to Archimedes to employ his ingenuity in detecting the fraud. Ruminating upon this subject when he was in the bath, he observed that he dislodged a quantity of water corresponding to the bulk of his own body; and instantly quitting the bath with all the eagerness natural to an inventive mind upon a new discovery, he ran into the street naked, crying, Εὕρηκα! Εὕρηκα! *I have found it! I have found it!* Then taking one mass of gold and another of silver, each equal in weight to the crown, he carefully observed the quantity of fluid which they alternately displaced when introduced in the same vessel full of water. Next he ascertained how much water was displaced by the crown when put into the same vessel full of water; and, upon comparing the three quantities together, he ascertained the exact proportions of gold and silver of which the crown was composed.

Archimedes's knowledge of the mechanical powers is familiar to every one. His celebrated saying with regard to the power of the lever has been often repeated,—"Give me a place to stand upon (ποῦ στῶ), and I will move the earth." In order to show Hiero the effect of mechanical powers, it is said that by means of ropes and pulleys he drew towards him a galley which lay on the shore manned and loaded. The displays of his mechanical skill at the siege of Syracuse, mentioned by Marcellus, were long deemed incredible, until the subsequent improvements in mechanics had demonstrated their practicability. He harassed the vessels of the besiegers, both when they approached and kept at a distance from the city. When they approached, he sunk them by means of long and huge beams of wood; or, by means of grappling hooks placed at the extremity of levers, he hoisted up the vessels into the air, and dashed them to pieces either against the walls or the rocks. When the enemy kept at a distance, he employed machines which threw from the walls such a quantity of stones as shattered and destroyed their vessels. In short, his mechanical genius supplied strength and courage to the city, and filled the Romans with astonishment and terror. The account of Archimedes's instrument for burning ships at a great distance by means of the rays of the sun was deemed fabulous and impossible, until Buffon invented and framed a burning glass, composed of a multitude of plane mirrors, capable of setting fire to wood at the distance of 200 feet, of melting lead and tin at 120 feet, and silver at the distance of 50 feet.

But, however eminent for mechanical invention, he was still more eminent for the investigation of abstract truths, and the deduction of conclusive demonstrations in pure geometry. Plutarch also mentions that Archimedes himself esteemed mechanical inventions greatly inferior in value to those speculations which convey irresistible conviction to the mind. His geometrical works afford numerous proofs of his success in this field of science. It is reported that he was often so deeply engaged in mathematical speculations, as both to neglect his food and the care of his person; and at the bath he would sometimes draw geometrical figures in the ashes, and sometimes upon his own body after he was anointed according to the custom of that time. He valued himself so much upon the discovery of the ratio between the sphere and the containing cylinder, that he ordered his friends to place upon his tomb a cylinder containing a sphere, with an inscription explanatory of its nature and use.

When Syracuse was taken by storm, Archimedes, ignorant of the fact, was run through the body by a soldier, while engaged in drawing a geometrical figure upon the sand. As Marcellus had given express orders that both his person and his house should be held sacred, this appears to have happened through ignorance, and therefore removes a great part of the odium from the Roman name. This event happened in the 142d Olympiad, or 212 years before the Christian era. Marcellus, in the midst of his triumph, lamented the death of Archimedes, conferred upon him an honourable burial, and took his surviving relations under his protection; but greater honour was conferred upon him when the philosopher of Arpinum, 140 years after, went in search of his long-neglected tomb. "I diligently sought," says Cicero, "to discover the sepulchre of Archimedes, which the Syracusans had totally neglected, and suffered to be overgrown with thorns and briers. Recollecting some verses said to be inscribed on the tomb, which mentioned that on the top was placed a sphere with a cylinder, I looked around me upon every object at the Agrigentine gate, the common receptacle of the dead. At last I observed a little column which just rose above the thorns, upon which was placed the figure of a sphere and cylinder. 'This,' said I to the Syracusan nobles who were with me, 'this must, I think, be what I am seeking.' Several persons were immediately employed to clear away the weeds and lay open the spot. As soon as a passage was opened, we drew near, and found on the opposite base the inscription, with nearly half the latter part of the verses worn away. Thus would this most famous and once most learned city of Greece have remained a stranger to the tomb of one of its most ingenious citizens, had it not been discovered by a man of Arpinum."

The following works of this celebrated mathematician have escaped the wreck of time:—1. *On the Sphere and Cylinder:* 2. *On the Dimension of the Circle*, or the Proportion between the Diameter and the Circumference: 3. *On Obtuse Conoids and Spheroids:* 4. *On Spiral Lines:* 5. *On the Quadrature of the Parabola:* 6. *On Equiponderants and Centres of Gravity:* 7. *On Bodies floating on Fluids:* 8. *The Arenarius:* 9. *Lemmata;* but the genuineness of this last has been doubted.

The existing works of Archimedes were printed at Basle, in a folio volume, Greek and Latin, in 1544. This is the *editio princeps.* Another edition was printed at Paris in 1615. The most complete and best is that of Torelli, printed at Oxford in 1792, folio. There is a French translation of his works by M. Peyrard; and an English translation of the *Arenarius*, by G. Anderson, London, 1784.

ARCHIMEDES-SCREW PROPELLER. See STEAM NAVIGATION.

ARCHIMIMUS, in *Antiquity*, the chief mimic actor or

pantomime, who sometimes at funeral processions represented the character of the deceased, by imitating his voice and gestures. Suet. *Vesp.* 19.

ARCHINUS of Cœle in Attica, an eminent statesman who assisted Thrasybulus and Anytus in expelling the thirty tyrants from Athens, in B.C. 403. It was by his advice that the Cadmean or Ionic alphabet was introduced into all public documents in the same year. From an allusion in Plato, Dionysius of Halicarnassus and others have fallen into the mistake of attributing to Archinus a funeral oration.—See Plato, *Menex.* p. 403; Dion. Hal. *De adm. vi dicend. in Demosth.* p. 178.

ARCHIPELAGO, called by the Turks *Ak degniz*, the white sea, to distinguish it from *Cara degniz*, the black sea, is generally applied to that part of the Mediterranean extending from European Turkey and Greece on the west, to Asia Minor on the east, and stretching southward to the island of Candia.

The name Archipelago was unknown to the ancients, and is generally supposed to be a corruption of Αἰγαῖον πέλαγος, by which name, the derivation of which is uncertain, it was known to the Greeks. (See ÆGEAN SEA.) The ancients divided it into (1.) *Mare Thracium*, the northern part, extending southward to the northern coast of Eubœa; (2.) *Mare Myrtoum*, the south-western part, washing the shores of Attica and Argolis; (3.) *Mare Icarium*, the south-eastern part, extending along the coasts of Caria and Ionia.

The navigation of this sea is rendered difficult by the many islands and rocks with which it abounds, and by the frequent occurrence of sudden squalls, especially about the equinoxes; but it has a great number of safe and commodious gulfs and bays. Besides the Cyclades and Sporades, which are the two principal groups of smaller islands, it contains Eubœa, Samos, Chios, Lesbos, Lemnos, Imbros, Samothrace, &c. All these islands are mountainous, and many of them are of volcanic formation; while others are almost entirely composed of pure white marble, for which Paros, one of the Cyclades, in particular, is so celebrated. The larger islands have some very fertile and well-watered valleys and plains. The principal productions are wheat, wine, oil, mastic, figs, raisins, honey, wax, cotton, and silk. The inhabitants are much engaged in fishing; and the coral and sponge fishery are actively prosecuted among the Sporades. Manufactures are at a very low ebb; almost the only branch carried on being that of cotton-weaving. The climate is mild and salubrious; the heats of summer being tempered by the sea breezes, while the winters are less severe than on the neighbouring mainland. The men are hardy, well-built, and handsome; and the women are noted for their beauty. The islands of the archipelago are considered to belong partly to Europe and partly to Asia. At present the Cyclades form a portion of the Greek kingdom, while most of the other islands are subject to Turkey.

The name Archipelago, which was primarily given to the Ægean Sea, is now applied to various other seas which contain numerous islands, as the Eastern Archipelago, Caribbean Archipelago, &c.

ARCHISYNAGOGUS, the chief of the synagogue, the title of an officer among the Jews, who presided in their synagogues and assemblies. The number of these officers was not fixed, nor the same in all places, there being 70 in some, and in others only one.

ARCHITECT (Latin *Architectus*, Greek Ἀρχιτέκτων from the primitive words ἀρχή, the *beginning*, *origin*, or *cause*, and τεύχω, to *contrive*, *construct*, *build*), an originator, a contriver of structures; one who designs and executes works of architecture. An architect is either civil, naval, or military. To a civil architect the term is applied simply, without the qualifying adjective, and to the others with the distinctive adjective prefixed. Architecture requires of its professor that he be both a man of science and an artist. He has to study it as a useful science and as a decorative art; the former requiring a more than ordinary knowledge of all that natural philosophy teaches, together with a technical acquaintance with the mechanical arts used in building; and the latter a fine perception of what is competent to produce pleasing effects, and in what manner they may be combined to produce grandeur and beauty. It often happens, and particularly on the Continent, where indeed they do not generally profess to be otherwise, that architects are totally devoid of all technical knowledge of the details of their profession, in which case a surveyor or supervisor is required to carry the architect's designs into execution. Such architects are little better than mere draughtsmen. In this country there is a large class of persons called surveyors, most of whom are in fact mere measurers. They too assume the office and distinction of architects, and are frequently employed as such. Country builders, again, who are for the most part simply carpenters, masons, or plasterers, are not unfrequently allowed to execute their own designs, the result of which passes with the vulgar for architecture, and their authors are also called architects. Vitruvius, who, whatever may be his merits as an historian of architecture, certainly well understood what an architect should be, requires him to be versed in almost every branch of science and art that was taught at the time he wrote.

Very few names of the architects of antiquity most deserving of celebrity have descended to us through authentic channels. Vitruvius was himself so obscure as not to be mentioned, or in any way referred to, by any ancient author whose works remain to the present time. Of the authors of the splendid architectural monuments of Egypt and India we know absolutely nothing. It is indeed but with difficulty and uncertainty that we can indicate the architects of the middle ages, the inventors and perfecters of that magnificent and beautiful style which, in the absence of a better generic name, has been called Gothic. They were mostly ecclesiastics,—frequently bishops and abbots.

When learning began to extend itself beyond the cloister, and science and the liberal arts were allowed to shed their influence on the minds of men, their application to useful and agreeable purposes became the occupation or profession of distinct classes. These had, of course, to derive reasonable emolument from their respective professions, and it was generally made in the shape of fees. Fees, however, could not be well determined in some professions, and among them in that of architecture. At first the architect was paid so much for a design, and a salary as supervisor or surveyor of its execution; but the established custom in this country now is, that the architect shall be paid a commission of five per cent. on the cost of the structure he is engaged to design and execute. For this he makes the design; an estimate of the expense, if required; a specification of everything required to be done by the builder, by contract or otherwise; with working drawings, and drawings of details. He superintends the execution of the structure, and measures and values the whole of the work if necessary, when completed, to check the builder's accounts. (W. H—G.)

ARCHITECTURE.

[NOTE.—The expressions in the following treatise, *present*, *recent*, and others implying a certain time, must be understood to have reference to or about the year 1830, when it was first written.]

History.

THE term Architecture is derived from the name of its professor, *Architect.* It is the art of contriving and constructing buildings; and the thing produced is by metonymy called by the name of the art which produces it, as the art itself is named from its professor. The word is directly from the Latin *architectura*, irregularly formed from the deponent verb *architector*, which is itself from the Greek substantive αρχιτεκτων, Latinized *architector*, *architecto*, and *architectus;* all of which are used by Latin authors. A more regular but less relevant derivation of the Latin words *architectus* and *architectura* is found in the substitution of the participles of the verb *tego*, *to cover*, &c. for the derivative of the Greek τευχω, *to build*, &c.

When architecture is spoken of simply, without a qualifying adjective, the designing and building civil and religious edifices, such as palaces, mansions, theatres, churches, courts, bridges, &c. is intended; and it is called civil, to distinguish it from naval and military architecture. Although every description of building may thus have the term applied to it, it is by common consent restricted to such edifices as display symmetrical arrangement in the general design and fitting proportions in its parts, with a certain degree of enrichment effected by means of cornices, blocking courses, and quoins, or by pillared, columnar, or arcaded arrangements. Architecture may indeed be said to bear the same analogy to building, that literature does to language. A plain brick wall covered in the ordinary way with bricks on their edges is not architectural, because it is poor, rude, and unadorned: it produces no pleasing effect, and is such as a totally uninstructed workman would construct merely to answer the purpose required of it. As man, however, is endowed by nature with a taste for beauty and elegance, mere rugged utility does not delight him; as he becomes civilized, he seeks to embellish whatever he produces, that it may give him positive instead of negative pleasure, by presenting to his sense of vision what his mind may dwell on with complacency; and he is thus disposed to avail himself of the dispositions and decorations which constitute architecture. It may be asked, what standard of beauty there is in this art, on which taste may be formed; though it must be obvious, that, like other children of the imagination, such as poetry and music, no other can be assigned than such compositions and modes of arrangement as by their harmony and simplicity attract the attention of the rudest mind, which is pleased without being conscious why, and of the most learned or practised, which discovers in them those proportions and peculiarities of form which always produce the most pleasing impressions, and appear to be dictated by nature. Painting and sculpture have, to a certain extent, their originals in the external works of nature, so that the most uncultured taste may be gratified, or otherwise, with them, as they give faithful or unfaithful representations; music is more artificial, and the taste must be cultivated to judge of and enjoy its higher productions; but architecture is purely conventional, requiring a knowledge of its system, and a mind informed as to the principles on which it depends for beauty, even to its appreciation.[1]

As it is necessary, in erecting a new edifice where an old one has stood, to remove all that was falsely constructed and insecure, if not entirely to clear out the foundations; so it is at this time necessary, in writing a treatise on architecture, to show the false grounds on which the old system is founded, and remove the false impressions which it has generally induced.

The earliest extant author on the subject is Vitruvius, who, being ignorant of any other than his native architecture, which was Roman, and generally derived from the Greek, concocted or adopted a silly fable about the origin of building, and pretends to trace from it the invention of what are called "the orders" by the Greeks; giving, however, to each a separate fable of its own. He professes to give the proportions, arrangements, and disposition of the architectural works of the latter people, and the rules by which they were composed. He describes with considerable minuteness various species of temples and other edifices of both the Greeks and Romans, and endeavours to give reasons for almost every thing connected with them. His account of the advance of man from a state of savage wildness to civilization, the discovery and acquisition of fire, and progress in the art of building, made by the early fathers of the human race, is only surpassed in absurdity by his stories of the invention and proportioning of the various columnar ordinances of which the ancients made use; if we except perhaps the fact, that this crude system has been received and propagated throughout the civilized world ever since the resuscitation of the work four centuries ago. How could a man, who evidently knew nothing of the early history of the world, of the Celtic monuments, or of the history and architecture of Egypt and the East, be supposed capable of describing the inventions and advances in knowledge of the human race? Nor is this all: How can Vitruvius be received as an authority, when it is found that he does not correctly describe any existing edifice in either Greece or Italy, and that no example of ancient architecture, either Greek or Roman, is in perfect accordance with his laws? This we shall show in its proper place, and proceed now to take a view of the rise, progress, and history of our subject, without reference to the popular system, which is based on such fallacious ground.

Origin and history of architecture.

Although it is very probable that men built houses to shelter themselves from the inclemencies of the weather before they constructed temples to the divinity, yet it must be obvious to all who have studied the early history of the human race in connection with its antiquities, and have considered the analogies afforded by the rude and simple nations of the world at the present time, and particularly by those who occupied the western side of the Americas on the discovery of those continents, that though the art of building may have originated in the personal wants of man, the science of architecture was the result of his devotional feelings and tendencies. In Egypt and in India, in Greece and in Italy, in Gaul and in Britain, in Mexico and in Peru, structures connected with the worship of the divinity existed, and still exist, of the earliest date, or rather of dates beyond the range of positive chronological information; some evincing a greater and others a less advance in taste and refinement, but all retaining some analogy, bearing upon the same point, and tending to what may be called architectural arrangement.

[1] Count Algarotti, speaking of the absence of any thing in nature on which architecture may be modelled, says, "with good reason it may be said to hold the same place among the arts, that metaphysics does among the sciences." (*Opere del* Conte Algarotti, *edizione novissima, tomo* iii p. 25.)

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None of those countries, however, nor any other with which we are acquainted, present any thing intended for the personal accommodation of man in the early ages; nor is there any thing in the sacred structures that could for a moment induce the idea, that the dispositions of architecture arose in the construction and composition of domestic buildings. Every thing leads rather to the belief that devotion and superstition were the originators, carriers on, and, it may be almost said, perfecters of the science.

The modern tent and marquee may be assumed as the representatives of the earliest habitations of man; at first perhaps covered with branches, then with the bark of trees, and, in a more advanced state, with the skins of animals. It would not be till men began to congregate in towns and cities for mutual defence from the aggressions of each other, that any thing more permanent than such tent-like habitations would be thought necessary, or even convenient, as most of the tribes, if not all, were nomadic. In what manner the cities were fortified, whether by being surrounded with brick walls, or with defences of earth or mud, as the forts in India are at the present day, is not for us here to inquire; but we have no reason to suppose that the houses within them were better than the hovels of the inhabitants of such places in the East now, if they were indeed so good. The rude New Zealanders are found to fortify their villages very respectably, although their habitations are mere huts; and the ancient Mexicans and Peruvians are reported by their discoverers and conquerors to have made their towns or cities very secure by means of walls and other defences, and to have had considerable structures dedicated to the divinity, while their houses were of a mean and unpretending description. It is probable that timber was principally used in the ruder ages by men in the construction of their permanent habitations, for such is the material employed by the South Sea islanders to whom we have referred; and more particularly by the simpler and less savage tribes inhabiting the Friendly and Society Islands of the same hemisphere, who, moreover, thatch their houses with the large leaves of the cocoa-nut and bread-fruit trees. This supposition is supported, too, by the general tenor of the Mosaic history, and by the command which the Israelites received to burn with fire cities whose inhabitants were given to idolatry, which would not have been an efficient mode of destruction if such materials had been employed in building them as were then used in temples; for similar commands enjoined them to "overthrow their altars and break their pillars." Deut. chap. xii. and xiii. Jericho, also, and Hazor, were *burnt* by Joshua. Even so late as the establishment of the kingdom of Israel in the person of David, that monarch is represented to have built himself "a house of cedar." There is indeed no reason whatever for supposing that the dispositions of architecture were employed for domestic purposes till a comparatively late period; and at no time in the history of the human race has the art of building been rendered so subservient to the comfort and convenience of man in civilized communities, as it is at the present day. To that assertion the remains of Herculaneum and Pompeii, for their age, give the most decisive and satisfactory evidence; and since their time the fact will not be disputed.

If what we understand by the term architecture did not originate in, or grow out of, the mode of building which men employed in the construction of their own habitations, our next object must be to discover, whether it can be deduced from the mode they adopted in arranging and constructing edifices for the worship of the divinity.

History.

The earliest intelligible record in existence makes frequent mention of the building of altars, but without temples. The first act of Noah on coming out of the ark, was to build an altar; Abraham built altars at various times and in various places; Isaac and Jacob built altars, and the latter is the first said to have set up a stone under the circumstances detailed in the 28th chapter of Genesis. On awaking after his remarkable dream, he said, "Surely the Lord is in this place"—"this is none other but the house of God"—he "took the stone that he had put for his pillows, and set it up for a pillar, and poured oil upon the top of it, and he called the name of that place Bethel;" and then dedicating it to the Deity, he said, "and this stone which I have set for a pillar shall be God's house." Jacob set up a stone again on which to ratify his agreement with Laban in the most sacred manner. In many other parts of the Old Testament, stones, or pillars as they are called in some places, were set up as witnesses and memorials of sacred engagements. In the covenant at Shechem (Josh. xxiv. 26, *et seq.*), Joshua "took a stone and set it up there under an oak that was by the sanctuary of the Lord. And Joshua said unto all the people, Behold, this stone shall be a witness unto us, for it hath heard all the words of the Lord." After the battle with the Philistines at Mizpeh, in which the Israelites were conquerors, Samuel, who had prayed for their success, "took a stone and set it up between Mizpeh and Shen, and called the name of it Eben-ezer, saying, Hitherto hath the Lord helped us." 1 Sam. vii. 12. The analogy between these stones and the cromlechs of the ancient Celtic nations is too clear not to be observed. "It is remarkable," says General Vallancey, in his *Collectanea de Rebus Hibernicis*, "that all the ancient altars found in Ireland, and now distinguished by the name of cromlechs, or sloping stones, were originally called Bothal, or the House of God; and they seem to be of the same species as those mentioned in the book of Genesis, called by the Hebrews Bethel, which has the same signification as the Irish Bothal."[1] Of these cromlechs there are three kinds, the single upright stone or pillar; the same, with another stone laid on it crosswise; and two upright stones with a third placed on them, like an entablature on two columns; and this third kind, to distinguish it from the other two, has been called by the Greek descriptive name *trilithon*. It is evident, moreover, from the sacred text, that it was customary to offer sacrifices by these pillars or cromlechs; for on the return of the ark from Philistia (1 Sam. vi. 14, 15), the kine drew the cart on which it was placed into a field "where there was a great stone; and they (the people) clave the wood of the cart and offered the kine for a burnt-offering to the Lord," having placed the ark on the stone. Now the sacrificial stone or altar at Stonehenge is immediately before the great trilithon which forms the end of the hypœthral temple within the external peribolus, and that temple itself is doubtless of the same species as those which Moses built at Mount Sinai, and directed the people to construct on their arrival in the promised land (Exod. xxiv. 4, and Deut. xxvii. 2–6), which they afterwards did under the command of Joshua, the stones or cromlechs being multiplied for special purposes. Moses and Joshua set up twelve stones (probably trilithons), because of the number of the tribes: at Stonehenge there were five. Strabo, speaking of the temples of the Egyptians, describes the most ancient as being of vast extent, but of rude workmanship, without elegance, without grace, and without embellishment of any sort. What could this have been

Plate LI.

[1] *Coll. de Reb. Hib.* tom. ii. p. 211.

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but the same simple combination of sacred stones which, we have found, was the earliest species of temple on record, and one of which we may presume to be the earliest, in manner if not in date, in existence? Indeed, late travellers have discovered, at Amada in Nubia, about halfway between the first and second cataracts of the Nile, a temple which consists of square piers supporting plain squared blocks of stone, which form a simple entablature, occupying the mid-distance between the ruder Celtic structure and the finished Egyptian columnar arrangement. The Egyptians had made considerable advances on the rude model to which the Greek geographer refers, when the Israelites escaped from them, having already fallen into polytheism and idolatry; and changes in faith inducing changes in form, their temples might no longer retain their monotheistic simplicity, but must be arranged with more complexity to suit the purposes of a complex religion. Lucian and Herodotus both say that the most ancient of the Egyptian temples had no statues or images in them; but the express command given to the Israelites by Moses, in the passage just referred to in Deuteronomy, that the stones to be set up, and the altar to be made, should be of whole stones, and that no iron tool should be used upon them, warrants the supposition that it was to prevent them from doing what their late masters were then accustomed to do—carve the altar and piers or pillars with images, and so fall into idolatry; and may be admitted as a proof that the Egyptians had already made the advances in architecture which we have presumed: indeed we shall find that they had actually arrived at the splendid results which the ancient capital of Egypt even at this day presents. One of the colleagues of Denon, in a dissertation on the antiquity of Thebes, in the great work of the French Institute on the Antiquities of Egypt, says, "Let us add to all these considerations (that all the historians and philosophers of Greece and Rome agree in assigning the highest antiquity to the Egyptians) that most of the edifices of Thebes bear incontestable marks of great age. This is a fact not of a nature to produce a strong impression on those who have not seen the monuments themselves, but it helps to carry conviction to the minds of those who have been able, in the places where they exist, to compare the edifices of ancient Egypt with each other."[1] He goes on to speak of the causes of their preservation, and concludes with this passage:—"It may be remarked, moreover, that most of the ancient edifices of Thebes are composed of the ruins of other monuments which had perhaps themselves become ruined by age."

But Strabo and Herodotus agree in saying that the Indian caverns or excavations were justly presumed to be more ancient than the temples of Egypt; and a learned modern antiquary (the Rev. Mr Maurice) asserts that they were made by the Celtæ. Now the architectural arrangement of these excavations, and of Hindoo architecture generally, very much resembles that of the early Egyptian works. This coincidence strengthens the supposition that they had a common origin, and that indeed the forms of architecture originated in the simple combinations which we see in what are called the Celtic or Druidical remains; and it is not doubted that they originated in devotional feelings.

In assuming Stonehenge to be the oldest architectural monument (in manner, it may be, rather than in the date of its execution), we do not pretend to lower the antiquity of any other, but to put this beyond them all; believing it to be a specimen of primeval columnar architecture, which led the way, as one of the numerous gradations, some of which may have left no traces on the face of the earth, from the monolithic cromlech to the Parthenon of Athens, the Pantheon of Rome, and the Minster of York. It is not a sufficient argument against this assumption, that such structures are not found existing in the East at the present time; for they were doubtless swept away to make room for more ornate edifices, as the custom was, in the same sacred places, and to furnish materials for them; as the latter have in many cases been as completely obliterated from the face of the earth, with the cities to which they belonged. A specimen of the next step in advance exists in the temple at Amada; and, as we shall have occasion to show, it seems to demonstrate the truth of our position, by some of its square piers having been sculptured into cylinders, which exhibit the simplest form of the Greek Doric column.

This, however, is not the generally received opinion. It is thought that the trunks of trees used in the construction of human habitations first suggested the idea of columns; and that the lintels, transverse beams, wall-plates, and rafters, first furnished that of an entablature. Neither authentic history nor analogy appear to us to bear this out; for the most ancient architectural remains, in various places, accord less with the arrangements consequent on such an origin than those which are more modern; and it requires a great stretch of fancy to imagine the derivation of the Titanic structures of Thebes, Pæstum, and Selinus, from the posts of a woodman's hut. But the inquiry, being more curious than instructive, is not worth pursuing further; for indeed no useful result could arise from its determination.

Such being the case, we now proceed to trace the progress of the science from its earliest regular formations, of which we have sufficient and authentic information, down to the present day.

Indian architecture.

Indian chronology being so vague and undefined, and the connection of the Hindoos with the civilized nations about the Mediterranean Sea having been so much restricted in the earlier ages that we can get little assistance from the Greek historians on the subject, the date of their architectural monuments can be determined only by analogy. That, however, is an uncertain guide, especially in the circumstances in which we are placed, without proper delineations, and indeed without any work that gives a competent idea of them. Though we have held India so long, and by a so much more honourable tenure than the French did Egypt, if we were now to be dispossessed we should leave nothing, and we should certainly retain nothing, to show to our credit that we had ever held it. Such an undertaking as the great work of the French Institute on the Architectural Antiquities of Egypt is far beyond the means of individuals; the constitution of our government appears to preclude the application of funds from the public purse to such purposes; and the East India Company, from whom perhaps something of the kind on the archæology of India might have been expected, have, it would appear, occupations of more interest to them than the advancement of science and art. It may be generally stated, that, in its leading forms and more obvious features, Hindoo architecture strongly resembles Egyptian, and may be considered as of the same family with it.

Egyptian architecture.

No nation that ever existed within the annals of the human race has left structures that, in extent, magnificence, and grandeur, can vie with those of ancient Egypt. We have the authority of historians for believing that

[1] *Description de l'Egypte*, tome i. p. 432.

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there were others in the same country which no longer exist, that must have surpassed those which do remain; and they speak also of the cities of Assyria, as unparalleled in the extent and splendour of their edifices, whose sites, even, are not now determinable. The pyramids, however, mausoleums of a nation—and the temples, monuments of human folly—speak more strongly than any historian can, and compel our belief of what they have been by what they are; whereas the others do not exist but in name. Nineveh and Babylon were—but Thebes and Memphis still remain. It is strange, indeed, that a people who displayed such energies in the construction of tombs, pyramids, and temples, should have left no work of any description that could be applied to any really useful purpose. Denon, speaking of Thebes, says, "Still temples—nothing but temples—not a vestige of the hundred gates, so celebrated in history; no walls, quays, bridges, baths, or theatres; not a single edifice of public utility or convenience. Notwithstanding all the pains I took in the research, I could find nothing but temples, walls covered with obscure emblems, and hieroglyphics which attested the ascendency of the priesthood, who still seemed to reign over the mighty ruins, and whose empire constantly haunted my imagination."[1] Champollion, however, in his late researches, speaks of the remains of quays, and calls some of the structures palaces instead of temples; but as the former exist only in connection with the latter, they can hardly be considered as any thing more than mere embankments; and the regal and hierarchical offices having been so closely connected in the economy of ancient Egypt, it is of little or no consequence to our position whether the same edifices be called palaces or temples. Diodorus Siculus says, in one place, that "Busiris," believed to be one of the Pharaohs who persecuted Israel, "built that great city which the Egyptians call Heliopolis and the Greeks Thebes, and adorned it with stately public buildings and magnificent temples, with rich revenues;" and that "he built all the private houses, some four, and others five stories high."[2] Shortly after, speaking of Memphis, to account for the splendour with which the Egyptians built their tombs, and the comparative meanness of their houses, the same author says, "They call the houses of the living inns, because they stay in them but a little while; but the sepulchres of the dead they call everlasting habitations, because they abide in the grave to infinite generations. Therefore they are not very curious in the building of their houses; but in beautifying their sepulchres they leave nothing undone that can be thought of." Strabo also speaks of a splendid dwelling which was erected for the priests at Heliopolis, but that probably was one of the sacred palaces just referred to; for none of the ancient writers describe the domestic structures of the Egyptians, from personal knowledge of them, as being worthy of any notice; and that assertion of Strabo is too loose and unsupported by contemporary authority or analogy to deserve confidence of itself. To the statement of Diodorus, that private houses were built to four and five stories high, we can give no credence whatever; for the construction of edifices in tiers or stories was very imperfectly understood even in his time, which was many centuries after the destruction even of Thebes; and none of the existing remains of that city give the slightest indication of a second story, or indeed of aptitude to construct one, except the rude landings in some of the propylæa. Herodotus says that the Egyptians were the first who erected altars, shrines, and temples; but of their private houses he says nothing; neither does he describe any of the temples as they existed in his time in Egypt; so that he in fact affords no assistance in determining the comparative antiquity of the various architectural structures which remain to the present time in that country. Indeed the ancient historians and topographers speak for the most part so widely of dates and dimensions, that they are, at the best, most unsatisfactory, if not fallacious, guides; and in the present case, that of Egypt, the style of architecture is so uniform, or so imperfectly understood, that no argument can with safety be drawn from it, as there may in other cases. In Hamilton's *Ægyptiaca*, the author says, with reference to this question: "In Egyptian architecture there is an uniformity of structure, both in the ornaments and in the masses, which, if unassisted by other circumstances, reduces us to mere conjecture; and that not only for the difference of a century or two, but perhaps for a thousand years."[3] Again: "The monuments of antiquity in Upper Egypt present a very uniform appearance; and his first impressions incline the traveller to attribute them to the same or nearly the same epoch. The plans and dispositions of the temples bear throughout a great resemblance to one another. The same character of hieroglyphics, the same forms of the divinity, bearing the same symbols and worshipped in the same manner, are sculptured on their walls from Hermopolis to Philæ. They are built of the same species of stone; very little difference is discernible in the degrees of excellence of workmanship, or the quality of the materials; and where human force has not been evidently employed to destroy the buildings, they are all in the same state of preservation or decay."[4] But we are fortunately now about to be rid of that difficulty by the erudition and industry of those learned men who have given their attention to the hieroglyphic literature of the Egyptians. M. Champollion professes to have determined the date of every monument of antiquity in that country which is inscribed, by the inscriptions, which he has qualified himself to read. As yet, however, we are not in possession of the whole result of his discoveries.

Hypogea, or spea, being caves formed by excavation, are of earlier date than any existing structures. Internally they present square piers, which were left to support the superincumbent mass of mountain or rock when their magnitude rendered it necessary. These were originally tombs; and the cave of Machpelah, of which Abraham made the purchase as a burying-place for his family, was, doubtless, one of that kind. Oratories or chapels were afterwards made in the same manner, but, it would appear, not until columnar architecture had come into use; for their entrances are generally sculptured into the resemblance of the front of a rude portico, or an actual portico or pronaos is constructed before them. Many such are found on the banks of the Nile, in its course through Nubia and Egypt. At Ibrim, which the Greeks call Primis, in the former country, there are several of these cavern temples, the earliest of which, according to M. Champollion, bears date of the reign of one of the Pharaohs, who was contemporaneous with Abraham, or his son Isaac, or about eighteen centuries before Christ; the latest is of the time of Rhameses Sethos, the Sesostris of Greek history. To some of the cavern tombs and temples in Upper Egypt M. Champollion accords even a still higher degree of antiquity. The earliest columnar structures which are found within the same range of country do not appear to bear a higher date than that of the

[1] *Voyage dans la Basse et la Haute Egypte*, p. 176. Par V. Denon.
[2] Diod. Sic. lib. i. cap. iv.
[3] *Ægyptiaca*, by Wm. Hamilton, Esq. F. S. A. Part I. p. 280.
[4] Ibid. p. 18.

earliest kings or Pharaohs of the eighteenth dynasty of Manetho, which began about the time of the Jewish patriarch Abraham and ended with the Pharaoh from whom his descendants escaped under the conduct of Moses. The temple at Amada, to which we have already referred, is of the time of Moeris, who was contemporary with the patriarch Jacob, and consists of twelve square piers or pillars, and four columns, which possess the form and character of the Greek Doric, and may it is suggested, be called *protodoric*. The same intention, if it may be so called, is found in others of the early monuments, but in none so perfect as in this, as almost all the structures of ancient Egypt were either destroyed or seriously damaged by the Persians at the time of their invasion under Cambyses; and they are supposed not to have ascended the Nile much above Psalcis or Dakkè, but to have turned off by the way across the desert to Ethiopia, so that the temple at Amada, which is considerably above Dakkè, escaped.

Of all the Pharaohs, Sesostris, the first of the nineteenth dynasty, was the most distinguished for the great and extensive works he executed in architecture. Most of the existing ruins in Egypt, anterior to the Persian invasion, are attributed to that monarch by M. Champollion. The immense ruins at Thebes, which have been called the Memnonium and the tomb of Osymandyas, and are popularly called Medinet Abou, are considered by the same inquirer to be those of the Palatial Temple of Rhameses the Great, or Sesostris, and which he therefore calls the Rhamesseion, the ruins at Luxor being those of the Memnonium; that edifice or series of edifices having been constructed by Amenophis Memnon, of the eighteenth dynasty, one of the good and beneficent princes by whom the children of Israel were protected during their sojourn in Egypt. The magnificent structure at the village of Carnack, within the same city, appears however to excel all the rest in extent and grandeur, and is at least their equal in antiquity. It is generally known as the temple of Carnack, but it has been distinguished as that of Jupiter Ammon. It bears inscribed the name of Thothmosis II., the predecessor of Amenophis Memnon. From the existing remains of Thebes, and the relations of historians combined, that city may be assumed to have attained its highest degree of splendour in the time of Sesostris; few of the ruins it presents being of later date than the time of that monarch. This being admitted, and we believe it can hardly be denied, it must be admitted also that the practice of architecture, and of the allied mechanical arts, were already well understood; for the composition of the monuments displays an exquisite combination of simplicitly and harmony, which produce the finest effects of beauty and grandeur; while their construction is the apparent result of perfection in the use of mechanical powers. All the Pharaonic monuments, indeed, throughout Egypt and Nubia, are wonders of science and art. The structures of Ombos, Apollinopolis Magna, and Latopolis, between Thebes and the cataract, M. Champollion determines to be generally of the age of the Ptolemies, and some even of the Roman dominion; those, however, which are of comparatively modern date are evidently restorations; others, probably of the earliest ages, having occupied the same sites. Indeed M. Champollion asserts generally that the Ptolemies, and the Ethiopian Ergamenes himself, only rebuilt temples where they had already stood in the times of the Pharaohs, and to the same divinities that had always been worshipped there; and he remarks, that the religious system of this people was such a complete whole, so connected in all its parts, and fixed from time immemorial in so absolute and precise a manner, that the dominion of the Greeks and of the Romans did not produce any innovation; that the Ptolemies and the Cæsars only restored in Nubia what the Persians had destroyed, and rebuilt temples where they had formerly stood, and dedicated them to the same gods.

Of the arrangements of an Egyptian temple we shall speak when we come to treat of Egyptian architecture as a style. In construction the Egyptians appear to have used wrought stones at a very early period: this probably was induced by the still earlier habit of excavating rocks to form tombs; for the walls in their oldest structures are composed of rectangularly cut blocks in parallel courses; whereas we shall find that the most ancient specimens of walling in Greece and Italy are not so. In the Pharaonic monuments, besides walls built in parallel courses of wrought stone, we find squared piers also; and frequently, in the same structure with them, the peculiarly formed tumescent column with a bulbous capital or head, covered with an abacus or square tablet, corresponding with the size of the piers, and warranting the supposition that that species of column is a mere refinement on the simple square pillar. What dictated its singular form must remain matter of speculation. The cylindrical column with a bell-shaped capital was the next advance, and that also is found in the same structures, though not in the simplest and earliest of them, in which piers occur. Terminal or Caryatic figures are common in those early works, not absolutely supporting an entablature, but placed before piers which do so, and having the appearance of doing it themselves when seen in front. Bold, massive, rectangular architraves extend from pier to pier and from column to column, and are generally surmounted externally by a deep coved coping, or cornice, with a large corded and torus-formed moulding intervening. This masks the ends of the stones which are placed transversely on the architraves to form the ceiling internally, the whole being flushed square on the top, and forming a flat terrace or floor. The pyramidal form of the moles or propylæa, peculiar to Egyptian temples, may have been suggested by the pyramids, as neither that form nor those adjuncts to a temple appear to have been used before the period at which it is supposed the former were constructed. The grandeur and dignity inherent to that form would indeed hardly be suspected till its appearance in the pyramids themselves; and certainly the impression of its effect must have been strong, to induce men to seek it in a truncated pyramid under a very acute angle, as in the propylæa, relying on the tendency of its outline alone. It was gradually, too, that this tendency was generally applied, for in the earliest Pharaonic structures the vertical outline is most common, except in the propylæa, where they exist; and in the structures of the Ptolemies the inclined outline pervades every thing. The monolithic obelisk is of Egyptian origin also. Its tapering form may be the consequence of the impression the pyramidal tendency had occasioned, though perhaps the object itself is the representative of the single stone by which religious feeling appears first to have expressed itself. Obelisks were set up by the Egyptians, sometimes in the courts or atria of their temples, and sometimes before the entrances to them.

Of all the architectural works of the Egyptians, however, none have excited so much the wonder and curiosity of men as the pyramids themselves; not in consequence of any particular beauty in their composition, or ingenuity in their construction, but simply because of their immense magnitude, and unknown use, and antiquity. Denon makes the following observation on his first visit to the great pyramid of Gizeh, at Memphis. "If we reflect upon these pyramids, we shall be inclined to think the pride that constructed them greater even than these masses them-

selves, and shall scarcely know whether to reprobate most the insolent tyranny which commanded, or the stupid servility of the people which executed, the undertaking. None but sacerdotal despots would ever have undertaken them, and none but a stupid fanatical people would ever have built them....The most honourable reason that can be assigned for their erection is the emulation of man to excel the works of nature in immensity and duration, and in this project he has not been altogether unsuccessful. The mountains near the pyramids are not so high, and have suffered more from time than the pyramids themselves."[1] But Memphis itself was of late foundation in comparison with other cities on the Nile. According to Professor Heeren,[2] civilization descended by the Nile from Ethiopia with the caste of priests who brought with them the worship of Ammon, Osiris, and Phtha (the Jupiter, Bacchus, and Vulcan of the Greeks), and " the spread of this worship, which was always connected with temples, affords the most evident vestiges of the spread of the caste itself; and those vestiges, combined with the records of the Egyptians, lead us to the conclusion that this caste was a tribe which migrated from the south, above Meroe, in Ethiopia, and, by the establishment of inland colonies around the temples founded by them, gradually extended and made the worship of their gods the dominant religion in Egypt. Proofs of the accuracy of this theory," he asserts, " may be deduced from monuments and express testimonies concerning the origin of Thebes and Ammon from Meroe; that it might indeed have been inferred from the preservation of the worship of Ammon in this last place." The same author goes on to say, that " Thebes was, if not the most, one of the most, ancient cities of Egypt;" and that " Memphis and other cities of the vale of the Nile are known to have been founded from Thebes." Now Thebes exists to the present time in the ruins of her magnificent temples, the works of the Pharaohs, but without the vestige of a pyramid, so that it may be concluded that none was ever built there; and Memphis may be said to exist in the everlasting pyramids of Gizeh and Saccharah, which occupy two of its extremities; but no indication remains of the existence of a temple of any kind: indeed the exact site of the city cannot be determined except by the pyramids. Herodotus, however, speaks of temples at Memphis, particularly of that of Vulcan or Phtha; but certainly no vestige of such has existed for a long period of time within that vicinity. Memphis was a great and ancient capital, and why should it not retain some evidence of the existence of temples in it? But Thebes was a greater and more ancient capital, and indeed the metropolis of all Egypt; and why has it no pyramids? These things are equally unaccountable and inexplicable, affording groundwork for almost any theory, but giving perfect support to none. Mr Hamilton, in his *Ægyptiaca*, before quoted, places Memphis considerably further south, where some ruins have been discovered which may be thought to give a colour to his supposition. But the ruins are of very inconsiderable extent, and are all prostrate, so that nothing can be positively determined by them; and the statement of Pliny as to the relative distances of the Nile and the city from the pyramids of Gizeh being proved to be correct in the one, may be admitted in the other. If Herodotus's account of the building of the pyramids be received, they are of comparatively modern date, the oldest having been constructed several generations after the time of Sesostris, under whom Thebes attained its highest degree of splendour; but this would leave unaccounted for the tendency to pyramidal forms in Egyptian architecture before referred to, unless every example exhibiting that tendency were itself referred to a date posterior to that assigned to Cheops and Cephron, which cannot be done in accordance with the assertions of M. Champollion as to the structures of Thebes, Elephantina, and Nubia generally.

From its immense size, the dimensions of the great pyramid of Gizeh, at Memphis, are variously given by the various persons who have measured it. M. Nouet, who was of the French commission in Egypt, and had perhaps the best means of ascertaining the truth, states its base to be a square whose side is 716 French or 768 English feet in length, which is about the extent of the great square of Lincoln's-Inn-Fields in London; and its height 421 French or 452 English feet, or about one-third as high again as St Paul's Cathedral. It is built in regular courses or layers of stone, which vary in thickness from two to three feet, each receding from the one below it to the number of 202; though even this is variously stated from that number to 260, as indeed the height is given by various modern travellers at from 444 to 625 feet. And the ancient writers differ as widely, both among themselves and from the moderns. On the top course the area is about 10 English feet square, though it is believed to have been originally two courses higher, which would bring it to the smallest that in regular gradation it could be. It is a solid mass of stone, with the exception of a narrow corridor leading to a small chamber in its centre; and a larger ascending corridor or gallery, from about half the distance of the first to another larger chamber at a considerable distance, vertically above the former, in which there is a single granite sarcophagus, not more than large enough for one body, putting the intention of the structure clearly beyond doubt. The other pyramids differ from that of Cheops (as the largest is called) in size, and slightly in form and mode of construction, some having the angles of the steps or courses of stone worked away to an inclined plane, and some not diminishing in a right line. One of the middle-sized pyramids is unlike all the rest, in being neither smooth nor in small steps, but in six large benches or stages, apparently of equal height, and diminishing gradually. But the circumstance which most distinguishes it is, that it is constructed of rude unshapen blocks of stone, cemented together with a very large proportion of mortar. Another is of unburnt brick, and has consequently become ruinous and mis-shapen.

The famous labyrinth, of which Herodotus speaks as having been built by the twelve kings of Egypt, beyond the Lake Mœris, is believed by Denon, after examination of the described site, to be little better than fabulous, and that the historian was imposed on by the priests, from whom he derived most of his information. He says, indeed, that he saw and examined it himself; but his description is so vague, that an architect who should endeavour to make a design from it, would be greatly embarrassed. As we can therefore derive no information from it with regard to architecture, it need not be further discussed here. It has been suggested as probable, and indeed the opinion has been maintained, that the pyramids stand over immense substructures; that their areas are occupied by chambers, in which may be found the arcana of Egyptian lore, of which they are the depositories. If it really be so, may not the labyrinths just referred to have been under the pyramid, which the historian says was constructed at the point where the labyrinth terminates, instead of near it? His expression is so ambiguous, that it leaves room for a suggestion of the kind.

Of the domestic architecture of the Egyptians we have

[1] *Voyage dans la Basse et la Haute Egypte*, p. 77. Par V. Denon.

[2] *Manual of Ancient History*, p. 58.

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no knowledge whatever. The statements of the ancient writers on the subject have been already mentioned; but supposing them to be more explicit, and more in conformity with probability, than they really are, without existing remains we could form but a very imperfect idea of what it was. Reasoning from analogy, and the slight information of historians, we should conclude that the habitations of the Egyptians were of a very unpretending description. The already quoted statement of Diodorus Siculus, that "they are not very curious in the building of their houses," even in his time, after their long intercourse with Greece, and their more recent connection with luxurious Rome; added to the fact, that no indications of domestic structures exist in any part of the country, and that the presumed habitations of the priests, in the ancient temples, are small and inconvenient cells; and all these things, taken in conjunction with the mildness of the climate and the salubrity of the atmosphere, we think it must be admitted, warrant the conclusion.

No style of architecture of which we have any knowledge is so well qualified to produce impressive effects on the mind as the Egyptian. The mere assumption of its forms, however, is not sufficient to produce its effects; and drawing is more incompetent to convey an idea of it than perhaps of any thing else in art. To this point the authors of the great work of the French Institute on the antiquities of Egypt bear testimony in strong language. Speaking of the incompetence of drawings to convey just ideas of the grandeur, magnificence, and beauty of the Egyptian temples, and other remains of antiquity, they say, "Despite the care we have given ourselves to describe the Egyptian monuments, we cannot even hope that we have succeeded in giving to others the ideas which we ourselves received from actual views and present contemplation of them; for there are things which drawings and descriptions cannot convey. Geometrical drawings are without doubt quite competent to show the form and proportions of an edifice, its disposition and distribution; but far indeed are they from giving satisfactory ideas of the elegance and effect of structures. Frequently we had to regret how much of the beauty of the original was lost in its geometrical representation on paper; for what in execution was light and graceful, often in the geometrical drawings appeared heavy and inelegant."[1]

The materials used in the construction of the Egyptian architectural monuments are, for the most part, granite, breccia, sandstone, and unburnt brick. The granite was principally supplied by the quarries at Elephantina and Syene, for which the Nile offered a ready mode of conveyance; some species were brought down the river from Ethiopia, but we do not find that the materials were at any time brought from any other foreign country. It may be remarked, too, that in the earliest structures the common *grès* or sandstone is principally employed. Excepting the obelisks and some few of the propylæa, all the temples at Thebes are of that material. In Lower Egypt, on the contrary, and in the works of later date generally, almost every thing is constructed of granite.

Persian, Assyrian, and Phœnician architecture.

Herodotus informs us that the ancient Persians had neither statues, temples, nor altars; and Diodorus Siculus affirms that the palaces of Persepolis and Susa were not built till after the conquest of Egypt by Cambyses, and that they were constructed by architects of that nation. In this case, as in that of India, we are at a great loss for evidence. The Persepolitan remains, though frequently visited and slightly sketched, have not been explored and delineated by such men as Stuart and Revett, or the authors of the great French work we have so often alluded to. That the Persian style, though very different in particulars, does bear a relation to the Egyptian family, however, is very evident. Sir Robert Ker Porter, in his travels in the East, says that the first impression he received in his first walk among the ruins of Persepolis was, that "in mass and in detail they bore a strong resemblance to the architectural taste of Egypt."[2] Nevertheless, there is a strong probability that the Persian is itself an original style, and that the resemblance is merely fortuitous, similar results arising from the same causes, as in Egypt and India; for the eastern parts of that country are believed to have been the earliest seat of the human race. Professor Heeren says of Persia, "It cannot be doubted, that long before the rise of the Persian power, mighty kingdoms existed in these regions, and particularly in the eastern part of Bactria; yet of those kingdoms we have by no means a consistent or chronological history—nothing but a few fragments, probably of dynasties which ruled in Media properly so called, immediately previous to the Persians;"[3] from whom the style of architecture may be derived, though indeed we know of no remains of earlier date than those which are properly called Persian. But we may be said to know nothing of Bactria; it may, and probably does, rival Elora, Salsette, and the banks of the Nile, in primitive specimens of architecture.

We have neither historical nor archæological information that can be depended on to prove what the state or style of architecture was among the ancient Assyrians. Lucian says, however, that their temples were less ancient than those of Egypt. The ruins believed to be those of the great capital of Babylonia present nothing but shapeless masses of brick, from which no idea whatever can be formed as to the style of architecture, or the progress it had made in that country; but some cylindrical and other seals and fragments, in *terra cotta*, found by excavation among those ruins, and now in the British Museum, are sufficiently in accordance with the rest of the eastern antiquities to be received as evidence of the general assimilation of its style of design with that which was common to the neighbouring nations.

The Phœnicians, we are told by Lucian, built in the Egyptian style; but their country retains no memorials of its ancient architecture by which we might confirm or correct his information. Doubtless Carthage and the other colonies of Phœnicia followed their parent country in this particular.

As far as we can judge from the trifling documents we possess of the architecture of the ancient Mexicans and Peruvians, it was of a rude but massive character, and may be thought also to resemble the early architecture of India, Egypt, and Persia more than we can see any reason for, except in the tendency of the mind of man to the same result when he is placed under similar circumstances. An impression to this effect appears to have been made on Humboldt, who, when speaking of a pyramidal mass of ancient Mexico, says, "It is impossible to read the descriptions which Herodotus and Diodorus Siculus have left us of the temple of Jupiter Belus, without being struck with the resemblance of that Babylonian monument to the *teocallis* of Anahuac."[4]

It is an illustration of the fact that the wants and fancies of man lead him to nearly the same results as he becomes civilized, without communication and consequent imitation, that the plans given by Sir William Chambers, of Chinese public and private buildings, might be taken

[1] *Description de l'Egypte*, vol. i. p. 292.
[2] *Travels in Georgia, Persia, &c.* by Sir R. K. Porter, vol. i. p. 579.
[3] *Manual of Ancient History*, p. 26.
[4] Humboldt's *Personal Narrative*, vol. i. p. 82.

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at the first glance, for either Hindoo, Greek, Roman, or Moresco—of course not considering magnitude of parts, but general forms and arrangements. Indeed, the remark may be extended beyond the mere plans; for all have, to a certain extent, insulated columns placed equidistant, and crowned with an entablature; and the general effect of many Chinese buildings is altogether Moorish.

Jewish architecture.

Architecture was not likely to flourish among the shepherd tribes of Israel. It is in agricultural and commercial countries, such as Egypt and Greece, that its noblest works are produced, and not among the nomades of Arabia and Palestine. Saul, the first king of Israel, appears to have had no settled place of abode; and the most sacred ceremonies of the Jewish religion were performed at Gilgal, where was the temple of unhewn stones set up by Joshua on taking possession of the promised land, and making a covenant between God and the people, until the building of the temple at Jerusalem in the place rendered holy by Abraham's great sacrifice. Saul himself was confirmed in the kingdom at Gilgal, and there the nation swore allegiance to him with sacrifices to the Almighty; but as yet nothing existed there in which to perform the rites, except the ancient Celtic structure to which we have alluded. Joshua also set up an altar in Mount Ebal, and in long after times a splendid temple was erected in one of the two neighbouring mounts, Ebal or Gerizim, where the Samaritans worshipped. Like his predecessor on the throne, David appears to have been but indifferently lodged till towards the end of his reign, when he is said to have built himself a house; and until the temple was built in the following reign, the ark of the covenant was never in a fixed place;—it was at one time in a private house, at another in captivity among the Philistines; and, indeed, King David expressed his shame that he had a house of cedar, whilst the ark of the Lord still dwelt in a tent. These things, and the fact that Solomon sent to Tyre for workmen, and indeed for an architect also, are, we think, conclusive evidence, that in whatever state architecture was among the Jews from the building of the temple at Jerusalem, it was very low before that time; and from the descriptions we have of that edifice itself in the Bible, it appears to have exhibited a greater degree of barbaric splendour than of classic elegance. From mere description, however, it is impossible to understand an unknown species of building, as many things we shall have occasion to refer to will clearly prove.

Few things have occasioned controversies more amusing, from the singularity of some assumptions, and the absolute futility of them all, than the style and manner in which Solomon's temple was built. Villalpanda, a Spanish Jesuit, appended to a commentary which he wrote on the prophecies of Ezekiel, a long dissertation on the first and second temples of Jerusalem, in which he insists that the theory and practice of permanent architecture commenced with the building of that temple by Solomon—that with it, " the orders," which, he says, are falsely attributed to the Greeks, came into existence—that indeed the design (from a passage in the first book of the Chronicles), perfect in all its details, was given to David, *drawn by the hand of God!* He moreover pretends to show, that the proportions assigned by Vitruvius to the different orders accord exactly with the descriptions given of the temple of Solomon; and accuses Callimachus of usurping the honour of inventing the Corinthian capital, which could not belong to him, as it was of divine origin, and had been executed in the temple at Jerusalem centuries before he was born. Some learned, and in some respects sensible men, have attempted to support this theory; and others have thought it worth while to controvert it, by proving that the architect and the principal workmen were all either Egyptians or Phœnicians, and that consequently the edifice must have been in the Egyptian style. A learned architect of the present day has endeavoured to show that it was in the Greek style, and that its form, proportions, and distribution, were not dissimilar to those of the temple of Ceres at Eleusis. As the Phœnicians, who were principally employed by Solomon, themselves built in the Egyptian manner, we think the probability is great that it was in the Egyptian or Phœnician style, as far as the Jewish ceremonial would permit; and certainly the descriptions of its distribution accord better with that of an Egyptian than of a Grecian temple. The pillars of Jachin and Boaz, which are said to have been set up before the temple, correspond exactly in relative situation with the obelisks in temples at Thebes. Clemens of Alexandria, too, gives a description of an Egyptian temple very much like that of the Jewish; and the palm-leaves, roses, fruits, and flowers, in the latter, are very common in existing specimens of the former, whereas in the Greek remains of early date no such things are to be found. Whether the Jews in after-times possessed a national style of architecture or not, we cannot tell: there is no reason, however, for supposing that they did; for their monotheistic structure at Jerusalem was not repeated in other places, as the temples of the heathen divinities were among the Greeks and Romans, by which they might have acquired a peculiar mode of composition and combination. The non-existence of a national Jewish style of architecture tends also to strengthen our position, that architecture did not originate in the disposition and decoration of buildings for domestic purposes, of which the Jews must, when settled, have made as much use as other nations; and a multiplicity of religious edifices, in the construction of which they might have acquired one, was forbidden by their code.

Pelasgic architecture.

In various parts of Greece and Italy, specimens of rude walling are found of such remote antiquity that they are, as by common consent, referred to the fabulous ages, and, for want of a more distinctive term, are called Cyclopæan. Now it appears, from the concurring evidence and opinions of most antiquaries, that a people who have been called Pelasgi, or sailors, migrated from Asia Minor, or the coast of Syria, at a very early period, and possessed themselves of various countries, some of which were unoccupied, and others inhabited by Celtic tribes. Mr Godfrey Higgins says that the Pelasgi were Canaanites, and being a hardy sea-faring race, they soon subdued the Celtic inhabitants of Delphi in Greece, or of Cumæ in Italy, who, from their first quitting the parent hive, never had occasion for an offensive weapon, except against wild beasts; and that they were the people who settled Carthage, Spain, and Ireland. Bishop Marsh has proved the Pelasgi to be Dorians, Dr Clarke has proved the Etrusci to be Phœnicians, and Gallæus has proved the Dorians to be Phœnicians. Thus, says Mr Higgins, the Pelasgi, the Etrusci, and the Phœnicians, are all proved to be the same. According to Professor Heeren, also, who affixes dates to the various migrations, the Pelasgi were of Asiatic origin. " Their first arrival in the Peloponnesus was under Inachus, about 1800 years B. C.; and according to their own traditions," he says, " they made their first appearance in this quarter as uncultivated savages. They must, however, at an early period, have made some progress towards civilization, since the most ancient states, Argos and Sicyon, owed their origin to them; and to them, perhaps with great probability, are attributed the remains of those most ancient monuments generally termed Cyclopic."[1] He adds, that the Hellenes, a people

[1] *Manual of Ancient History*, p. 119.

[2] The Celtic Druids, c. vi. § 29, p. 259.

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of Asiatic origin also, expelled the Pelasgi from almost every part of Greece, about 300 years after their first occupation of it; the latter keeping their footing only in Arcadia and in the land of Dodona, whilst some of them migrated to Italy, and others to Crete and various islands. The arrival of the Egyptian and Phœnician colonies in Greece, Professor Heeren thinks, was between 1600 and 1400 B. C.

The connection of Greece and Italy with each other, and with Egypt and Phœnicia, is thus made evident. The Cyclopæan structures, however, were the works of the rude Pelasgi before that connection took place, except as far as it existed in their having a common origin. They occupied, either simultaneously or consecutively, both Greece and Italy; and this accounts for the sameness of that peculiar and original mode of structure which, we have said, is found in both countries, though no evidence exists of its ever having been practised elsewhere. If, indeed, the things in question were the work of the earlier Celtic inhabitants, a still more remote date must be assigned them than they could derive from the Pelasgi; and this is the opinion of Mr Higgins, supported, he contends, by the suffrages of Dodwell, Clarke, and others, who say that the doorway called the Gate of the Lions, in the Acropolis of Mycenæ, is built exactly like the remains of Stonehenge. The most ancient specimen of Cyclopic walling is found at Tyrinthus, near Mycenæ. It is composed of huge masses of rock roughly hewn and piled up together, with the interstices at the angles filled up by small stones, but without mortar or cement of any kind. The next species is in stones of various sizes also, shaped polygonally, and fitted with nicety one to another, but not laid in courses. Specimens of this are found at Iulis and Delphi, as well as at the places already mentioned, in Greece, and in various parts of Italy, particularly at Cossa, a town of the Volsci. This also was constructed without mortar. The mode of building walls, which took the place of that, is not called Cyclopæan; it is in parallel courses of rectangular stones, of unequal size, but of the same height. This is common in the Phocian cities, and in some parts of Bœotia and Argolis. To that succeeded the mode most common in, and which was chiefly confined to, Attica. It consists of horizontal courses of masonry, not always of the same height, but composed of rectangular stones.

Plate LI. Fig. 14.

Fig. 16.

Grecian architecture.

The oldest existing structure in Greece of regular form is of far superior construction to the Cyclopæan walling, and must be referred to the Egyptian or Phœnician colonists. It is at Mycenæ, and consists of two subterranean chambers, one of which is much larger than the other. The outer and larger one is of circular form, and is entered by a huge doorway at the end of a long avenue of colossal walls, built in nearly parallel courses of rectangular stones, roughly hewn, however, and laid without mortar. Its external effect is that of an excavation, though the structure of the front is evident; and internally it assumes the form of an immense lime-kiln; its vertical section being of a somewhat conical form, under nearly parabolic curves, like a pointed, or what is vulgarly called a Gothic arch. The construction of this edifice was thought to afford clear evidence that the Greeks were acquainted with the properties of the arch; but in the most material point this was destroyed on finding that it consisted of parallel projecting courses of stone in horizontal layers, in the manner called by our workmen battering, or more correctly perhaps corbelling. It proves, however, that its architect understood the principle of the arch in its horizontal position; for Mr Cockerell has discovered, by excavations above it, that the diminishing rings of which the dome is composed are complete in themselves for withstanding outward pressure; the joints of the stones being partly wrought radiating, and partly rendered so by wedges of small stones driven tightly into them behind. The apex is formed, not by a key-stone, for the construction does not admit of such, but by a covering stone, which is merely laid on the course immediately below it. It may be added, that internally the lower projecting angles of the stones are worked off to follow the general outline. Though this is the largest and most perfect, its internal diameter at the base being 48 feet 6 inches, and its height from the floor to the covering stone 45 feet, yet edifices exhibiting similar structure are found in many other places in Greece itself, in Egypt, in Sicily, and in Italy. They all however tend to prove, that the principle of the construction of the vertical arch was unknown at the time of their erection in all those countries; and their erection is as evidently of the most remote antiquity, perhaps of the presumed era of Dædalus, to whom some have assigned many of them, as well as the discovery of so much of the principle of the arch as is exhibited in the arrangement of the horizontal rings or layers in the Mycenæan monument. Neither could the mechanical powers have been unknown to their constructors. In the edifice which we have described, and which is thought by some to be the Treasury of Atreus, or the Tomb of his son Agamemnon, mentioned by Pausanias as existing among the ruins of Mycenæ in his time, the inner lintel of the doorway is 27 feet in length, 16 feet deep, and nearly 4 feet thick, weighing, it is computed, upwards of 130 tons; and the lintel of the Gate of the Lions in the Acropolis of the same city, is, from its immense magnitude, also strongly illustrative of the great mechanical skill of the people of those times. As the Treasury of Atreus at present exists, it exhibits nothing like an attempt at decoration, except that the doorway is, on the outside, sunk in two faces all round, as if to harmonize with some architectural composition; and the interior of the edifice may be supposed to have been lined, probably with plates of metal, like the tower of Acrisius, as bronze nails for attaching them to the vault still remain. Some sculptured fragments of marble which have been found among the ruins of the fallen parts and the rubbish which chokes up the entrance, together with indications on the external front of the edifice that it was cased, have led to an ingenious attempt at restoration, upon the supposition that the fragments were parts of a frontispiece. The fact that such frontispieces were sometimes carved, and sometimes constructed, in connection with the entrances of excavated tombs and other *spea* in Egypt and Nubia, gives a degree of probability to the idea that it would not otherwise have; for the fragments do not resemble the earliest existing specimens of Greek architectural forms; though indeed these latter may be traced to Persepolis, and Ibrim in Nubia, according to several ingenious antiquaries and architects. In curious accordance with this Mycenæan structure is the ancient monument at New Grange, near Drogheda, in Ireland. Ruder in every respect than the former, in form, construction, and mode of access, it bears such a striking similarity to it, that it is almost impossible to be supposed the effect of mere chance. The opinion of Mr Godfrey Higgins, that the Pelasgi, who peopled many of the countries on the shores of the Mediterranean Sea, peopled Ireland also, appears to be supported by this coincidence between the so-called Treasury of Atreus, or Tomb of Agamemnon, in the Peloponnesus, and the monument at New Grange in Ireland.

Plate LI. Fig. 10.

We know of no columnar edifice in Greece, or elsewhere in the Grecian style, of earlier date than the ruined temple at Corinth, which is in the plainest and sim-

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plest form of what has been called the Doric Order, though it would be more correctly designated the Doric Style; for the term Order is objectionable, because it supposes rules and limitations to what in its best times was subjected to neither. As, however, it is the term best understood, we shall not hesitate to continue it. It is difficult, if not impossible, to ascertain where and in what manner the Doric order originated. The example we have referred to, though the earliest, does not differ in its leading features and characteristics from the more perfect specimens of later date; and it bears no direct and easy analogy to any species of columnar arrangement of other countries and earlier times. The story of Vitruvius, even supposing it rational, does not coincide with the Greek style of Doric at all, but, if with any thing, with the Roman examples of it, which at the best are mean and inelegant deteriorations of the simple and beautiful original. This author says that "Dorus, the son of Hellenus and of the nymph Orseis, king of Achaia and of all the Peloponnesus, having formerly built a temple to Juno in the ancient city of Argos, this temple was found by chance to be in that manner which we call Doric."[1] In another place he deduces the arrangements of this same order from those of a primitive log-hut in the first place, through all the refinements of carpentry, leaving nothing to chance, but settling with the utmost precision what, in the latter, suggested the various parts of the former. Chance in one case, and experience in another, however, are not enough for this author; but he also tells us that the Doric column was modelled by the Grecian colonists in Asia Minor, on the proportions of the male human figure, and was made six diameters in height, because a man was found to be six times the length of his foot; and that eventual improvements occasioned the column to be made one diameter more, or seven instead of six. "Thus the Doric column was first adapted to edifices, having the proportions, strength, and beauty of the body of a man!" The earliest examples of this order, however, are those which least agree with the primitive forms and proportions of Vitruvius; the columns at Corinth hardly exceed four diameters in height, while in later examples they gradually extend, till, in the temple of Minerva on the promontory of Sunium, the columns are nearly six diameters, being one of the tallest specimens of pure Greek origin ever executed. If the trunks of trees used in the structure of tents suggested the first idea of columns, and of the Doric in particular, as many contend, how is it that the earliest specimens discovered are the most massive? For the merest saplings would have formed the wooden proto-columns, and necessarily, when imitated in stone, they would not have been made more bulky than the less tenacious nature of the material required; much less would the slender wooden architrave have been magnified into the ponderous entablature of the primitive permanent architectural structures of all nations. In the construction of edifices with the trunks of trees, and timber generally, then, we do not find the origin of Doric architecture. If we have recourse to Egypt, the mother of the arts and sciences, we shall indeed find many things even in the more ancient structures which *may* have furnished an idea of the Doric arrangements to the fertile imagination of a Greek. The later works of that country cannot be trusted for originality, as they may themselves have been influenced by Greek examples; but we hardly dare assert that the Doric order was suggested by any thing in Egyptian architecture, though in making such assertion we should be supported by the opinions of many competent judges. The temple at Amada in Nubia can hardly be positively assumed as an example of the *proto-Doric*, though it may of the *proto-columnar*. Nevertheless, the example is striking, as it certainly possesses the Doric character. The broad square abacus, and the cylindrical or even conoidal tendency of the shaft, marked as it is, as if for fluting, with the plain, simple, and massive epistyle or architrave superimposed, are all in accordance with the Hellenic columnar ordinance; still there is nothing to connect that rude model with the positive and somewhat formally arranged example at Corinth with which we began. It must be remembered, however, that two connecting links between Egyptian and Greek architecture are lost; Lower Egypt, with its splendid capital Memphis, and Phœnicia; through which latter the learning and taste of the inhabitants of the former country appear to have taken their course; but of neither of these do we possess architectural remains that bear on the subject in question. In the Pharaonic structures of Thebes we find both the tumescent and the cylindrical columns; and an amalgamation and modification of the two would easily produce the Doric column, or something very much like it, which may have been executed in those places, and so transferred to Greece. Of the triglyphs, the most distinguishing part of the Doric entablature, there are many indications in the early works of Upper Egypt; and in the structures of the Ptolemies they are still more evident; though it may be objected that, in these, those indications were borrowed from the Greeks after the Macedonian conquest. But it must be borne in mind that the Egyptian nation did not change its character, religion, or usages by the change of its governors; and the Egyptians were, through the whole period of their existence as a nation, an originating and not an imitative people; whereas the Greeks seized on a beauty wherever they found one, and made it their own by improving it. The forms and arrangement, too, of many of the Greek mouldings, and the manner of carving to enrich them, are common in the earliest ornate works of the Egyptians; and such things are as strong evidence of community of origin, as the existence of similar words having the same meaning in different languages is of theirs. We may be asked, why the Greeks cannot be allowed to have originated that beautiful style of architecture which they brought to the perfection it displays in their works? To which we think it a sufficient answer, that it would be against the common course of events if it were so. In Egypt we can trace a progress from the ruder to the more advanced, and, with trifling discrepancies, to the most perfect; but in Greece, the earliest specimen of columnar architecture that presents itself displays almost all the qualities and perfections which are found in works of periods when learning and civility were at their acme in that country. We cannot find in Greece a stepping-stone from the Celtic or Pelasgic Gate of the Lions of Mycenæ, to the Doric columns at Corinth, and hardly to the Fane of Minerva in the Acropolis of Athens; and have therefore to seek the gradations among the people with whom we have seen they were connected, and whose country furnishes them in a great measure, if not entirely. Differences in climate and in political constitution, as well as in forms of religion, account sufficiently for the differences between the arrangements of the religious structures of the Greeks and those of Egypt. At the present day we find, that though they may be built in the same style, and for the worship of the same divinity, there is a wide difference between a church in Italy and a church in England, and a still greater between a church in the former country and

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[1] Vitruvius, lib. i. cap. i.

one in Scotland. The model, however, of the Greek temple is found in many places in Egypt, generally placed as a chapel or ædicula, subsidiary to, and in connection with, the larger structures, as well as in the earlier Nubian temples themselves.

None other than the Doric style or order was used in Greece till after the Macedonian conquest, about which period that beautiful and graceful variety called the Ionic was brought into use. It is as difficult to determine its origin as that of the Doric. Vitruvius says that the Ionian colonists, on building a temple to Diana, wished to find some new manner that was beautiful; and by the method which they had pursued with the Doric, proportioning the column after a man, they gave to this the delicacy of the female figure; in the first place by making the diameter of the column one eighth of its height, then by putting a base to it in twisted cords, like the sandals of a woman, and forming the capital with volutes, like the hair which hangs on both sides of her face. To crown all, he says that they channelled or fluted the column, to resemble the folds of female garments, by which it would appear that Vitruvius did not know that the Greeks never executed the Doric order without fluting the columns. "Thus," he goes on to say, "they invented these two species of columns, imitating in the one the naked simplicity and dignity of a man, and in the other the delicacy and the ornaments of a woman." It can hardly be doubted that the voluted or Ionic order did originate in Ionia, at least we know of no earlier examples of it than those which exist there; and it does not appear to have been known to the European Greeks, and certainly was not practised by them, till after the period we have indicated. It probably took its rise from some peculiarities in Persian architecture; though many believe that the Ionic order had a much earlier origin, deriving it from Egypt, where, it is true, many indications are found of its volutes in the spiral enrichments of capitals; but it must be observed that they are in edifices now ascertained to be of the age of the Ptolemies, and consequently later than the structures which exhibit the voluted order in Ionia and its islands. We think, too, that many persons are influenced in assigning a higher degree of antiquity to this style than facts will bear out, by their respect for the authority of Vitruvius; though Mr Gwilt (his latest translator into English) confesses that "upon his authority in matters of historical research not much reliance is to be placed."[1] We are willing to admit that much may be adduced in support of the opinion, that this style was known and used in Greece even before the age of Pericles; specimens of it having been found in connection with sculpture, certainly less perfect, and therefore presumed to be of earlier date, than the works of Phidias and his pupils and compeers.

It is no less difficult to determine the origin of what is called the Corinthian order. The not inelegant traditionary tale by Vitruvius of the invention of its capital, is the only *reason* of the name it bears. His account of the origin of this third species of columnar composition is more summary, and not less absurd, than that of the preceding. He says that it was arranged "to represent the delicacy of a young girl whose age renders her figure more pleasing and more susceptible of ornaments which may enhance her natural beauty." With much more reason might the Doric be called the Corinthian order; for, as we have stated, at Corinth there exists the oldest example of that style; whereas there is nothing, either in ruins or authentic record, to prove that the latter was ever known in that city. Columns with foliated capitals are not of very early date in Greece; earlier examples exist in Asia Minor, and foliage adorns the capitals of columns in some of the Pharaonic monuments of Egypt; not arranged, indeed, as in the later Corinthian capital, which by possibility may have been the result of some such accident as Vitruvius relates of Callimachus and the basket on the grave of the Corinthian virgin. The interior of the temple of Apollo Didymæus at Miletus in Ionia exhibits the earliest example of the acanthus leaf arranged round the drum of a capital in a single row, surmounted by the favourite honeysuckle; but that edifice was constructed about a century before Callimachus is understood to have lived. The only perfect columnar example in Greece itself of this species of foliated capital is of later date than, and is a great improvement on, that of Miletus; it is the beautiful little structure called the Choragic monument of Lysicrates at Athens. Specimens are less uncommon in Greece of square or antæ capitals, enriched with foliage, than of circular or columnar capitals; but they are almost invariably found to have belonged to the interior of buildings, and not to have been used externally. In considering Greek architecture, it is necessary to bear in mind that it ceases almost immediately after the subjection of Greece to the Roman power; for there are many edifices in that country in the style of columnar arrangement of which we are now speaking besides those referred to, but they belong to Roman and not to Greek architecture. The earliest of them perhaps, and certainly the least influenced by Roman taste, is the structure called the Tower of the Winds, or of Andronicus Cyrrhestes, at Athens. A spurious example of Greek Doric, evidently executed under the Roman domination, may be referred to here; it is that of the Agora, or Doric portico, as it is sometimes distinguished, in the same city.

Plate LVI Figs. 1, 2, & 3.

Besides the three species of columnar arrangement we have enumerated, the Greeks employed another in which statues of women occupied the place of columns. The *reason* of this too Vitruvius furnishes in a story which is, as usual, totally unsupported by history or analogy; but the consequence of it is, that such figures are called Caryatides; and the arrangement has been called by some the Caryatic order. The use of representations of the human and other figures with or instead of columns is, however, common in the structures of Egypt and India; and to the former the Greeks were doubtless indebted for the idea, though they appear to have restricted its application to human female figures. Mr Gwilt infers, from various facts connected with the worship of Diana Caryatis, "that the statues called Caryatides were originally applied to or used about the temples of Diana; and instead of representing captives or persons in a state of ignominy (as the Vitruvian story goes), were in fact nothing more than the figures of the virgins who celebrated the worship of that goddess."[2]

The only architectural works of the Greeks that remain to us of any consequence, besides temples, propylæa, and Choragic monuments, are theatres; but these latter do not retain any thing connected with architectural decoration to make them interesting, except to the architect and antiquary. They are generally situated on the side of a hill, and were rather excavated or carved out in the earth or rock, than built; except the proscenium and parascenium, which being at the lower part, in front, and requiring elevation, must of necessity be built; but very little of the constructed portions in any case exists. It does not appear that the theatres afforded any provision for sheltering the spectators, or indeed the ac-

[1] Gwilt's *Chambers's Civil Architecture*, p. 30.

[2] *Ibid.* p. 57.

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tors, from rain, except perhaps a covered cyrtostylar colonnade within the upper boundary wall, which, even when it existed, was of necessity very narrow and small for so large a number of people as were generally assembled; for the theatres were calculated to hold from five to fifteen and even twenty thousand persons. This, to say the least of it, must have subjected the public to great inconveniences, even in so fine a climate as that of Greece; for they were unsheltered from the sun at all times, and effectually debarred from a favourite amusement in wet weather.

No remains exist of the domestic structures of the Greeks; and we are too well aware, from the example of others, of the futility of following mere descriptions on the subject, to attempt it here; especially as the most explicit are those of Vitruvius, whom we know to have been ignorant of the arrangement of Greek temples, by those of them which exist, and may therefore reasonably suspect of ignorance with regard to things of which we have no remains. It may be taken for granted that the houses of the Greeks were less extensive than those of the Romans, as they were a poorer and less luxurious people; and we shall be able to determine those of the latter nation with great exactitude, from the actual remains of Roman towns and country mansions. The exquisite beauty of form and decoration which pervades every article of Greek origin, whether coins, medallions, vases, implements of war or husbandry, or even the meanest article of domestic or personal use of which we have specimens or representations, is evidence of the fine taste with which the mansions of the Greeks were furnished. However, ignorance of the use of the arch, inferior carpentry, the absence of glass, and ignorance of the use of chimneys, were disadvantages which the Greeks laboured under in the construction and convenient arrangement of their houses, that no degree of taste and elegance could completely countervail.

In the construction of their edifices, the Greeks seldom, if ever, had recourse to foreign materials; the stone used in their temples being almost invariably from the nearest convenient quarries, which supplied it of sufficiently good quality. The structures of Athens are built of marble from the quarries of Pentelicus, and those of Agrigentum of a fossil conglomerate which the place itself furnishes.

Invention of the arch.

We have taken it for granted that the Greeks were ignorant of the properties of the arch, having too high an opinion of their good sense to think that they could be acquainted with so useful and admirable an expedient, and never use it; and no instance of its adaptation occurs in the construction of Greek edifices before the connection of Greece with Rome took place. Whether its invention should be referred to Italy or not is another question. If the great sewer at Rome called the Cloaca Maxima was constructed in the time of Tarquinius Priscus, it must be conceded that the properties of the arch were known and the arch applied in that country at an earlier period than we know the principle to have been understood and applied elsewhere; for neither Egypt nor Greece, nor any of the Grecian colonies, can furnish evidence that it was known to either Egyptians or Grecians till a long time after the period referred to, and when it may have been communicated from Italy. But it is contended that the Cloaca Maxima, as it now exists, is a work of much more recent date, and that it may have succeeded the sewer constructed by the first Tarquinius, who was moreover himself a Greek. If the first part of the objection be correct, the evidence in favour of Italy is destroyed, as far as that work is concerned; the second is fallacious, because it is not necessary that the monarch should have brought the knowledge with him; though indeed he might have acquired it in Etruria, or it might have existed in Rome before his arrival there. Most writers on the subject are of opinion that the principle of the arch was not known, in Europe at least, nor to the nations of Western Asia and Africa, till after the Macedonian conquest, about which time it may have been invented, or acquired from some of the eastern nations who were visited by the conquerors. To these suggestions the objections hold that the arch was not applied in Egypt in the architectural works which remain of the Ptolemies, nor is it found in the Persian and Indian monuments which date beyond that period. The author of the *Munimenta Antiqua*, after a comprehensive review of all the authorities and examples on the subject, gives it as his own opinion that "Sicily was the country where this noble kind of ornament first appeared, and that Archimedes was the inventor of it."[1] The evidence appears, we think, generally stronger in favour of its Italian origin; but to whomsoever the invention may be attributed, and whensoever it was made, the Romans were the first to make extensive practical use of it; and by its means they succeeded in doing what their predecessors in civilization had never effected. It enabled them to carry secure and permanent roads across wide and rapid rivers, and to make a comparatively frail and fragile material, such as brick, more extensively useful than the finest marbles were in the hands of the Greeks without that principle. To the Greeks, however, the Romans were indebted for their knowledge of the more polished forms of columnar architecture; for, before the conquest of Greece, the structures of Rome appear to have been rude and inelegant. The few specimens of architecture which exist of date anterior to that period evidently resemble the works of the ancient Etrurians, who, though they had made considerable advances on the architecture of their Pelasgic ancestors, were far inferior in taste and refinement to the Greeks; yet it is to that people we are inclined to attribute the invention of the arch, from whom the Romans acquired their knowledge of its use, and that degree of civilization which they possessed before the epoch referred to. It may be presumed that the Etrurians had also originated the style of columnar architecture which Vitruvius describes and calls Tuscan; but as no example of it exists, at least nothing that answers his description of it, we cannot tell positively what it really was; for, as we have before remarked, descriptions without a model, of architecture particularly, are quite unintelligible, as far as understanding a new style goes. Whatever then was the style of architecture in Rome before the conquest of Greece, it was either exploded by the superior merit and beauty of what the Romans found in that country, or combined with it, though frequently the combination tended to destroy the beauty of both. In the porticoes of the temple of Antoninus and Faustina, and of the Pantheon, at Rome, the chaste simplicity of a Greek columnar composition is preserved, and in the magnificent dome of the latter edifice, and in the long extended aqueduct, it is fully equalled. But the triumphal arch of the Romans, a hybrid composed of columns and arches, is devoid alike of simplicity and harmony, indeed of every quality which constitutes beauty in architecture.

Roman architecture.

In the transference of Greek columnar architecture to Rome, a great change was effected, independently of those combinations. The less refined taste of the Romans

[1] *Munim. Antiq.* by Edward King, Esq. F.R.S. and S.A. vol. ii. p. 268.

could not appreciate the simple grandeur and dignified beauty of the Doric, as it existed in Greece. They appear to have moulded it on what we suppose their own Tuscan to have been; and the result was the mean and characterless ordinance exemplified in the lowest story of the theatre of Marcellus at Rome, and in the temple at Cora, between 30 and 40 miles south of that city. Not less inferior to the Athenian examples of the Ionic order, than the Doric of Cora is to the Doric of Athens, are the mean and tasteless deteriorations of them in the Roman temples of Manly Fortune and Concord. It was different, however, with the foliated Corinthian, which became to the Romans what the Doric had been to the Greeks—their national style. But though they borrowed the style, they did not copy the Greek examples. In Rome the Corinthian order assumed a new and not less beautiful form and character, and was varied to a wonderful extent, but without losing its original and distinctive features. The example of the temple of Vesta at Tivoli differs from that of the temple of Jupiter Stator in Rome, as much as the latter does from the ordinance of the choragic monument of Lysicrates at Athens; and all three are among the most beautiful examples of the Corinthian order in existence—if indeed they are not pre-eminently so—and yet they do not possess a single proportion in common. It must be confessed, moreover, that if the Romans had not good taste enough to admire the Doric and Ionic models of Greece, they had too much to be fond of their own, for they seldom used them. Both at home and abroad, in all their conquests and colonies, wherever they built, they employed the Corinthian order. Corinthian edifices were raised in Iberia and in Gaul, in Istria and in Greece, in Syria and in Egypt; and to the present day Nismes,[1] Pola, Athens, Palmyra, and the banks of the Nile, alike attest the fondness of the Romans for that peculiar style. We cannot agree with the generally received opinion, that Greek architects were employed by the Romans after the connection between the two countries took place; for the difference between the Greek and Roman styles of architecture is not merely in the preference given to one over another peculiar mode of columnar arrangement and composition, but a different taste pervades even the details: though the mouldings are the same, they differ more in spirit and character than do those of Greece and Egypt, which certainly would not have been the case if Roman architecture had been the work of Greek architects. Indeed, were it not for historical evidence, which cannot absolutely be refuted, an examination and comparison of the architectural monuments of the two countries would lead an architect to the conclusion, that the Corinthian order had its origin in Italy, and that the almost solitary perfect example of it in Greece was the result of an accidental communication with that country, modified by Greek taste; or that the foliated style was common to both, without either being indebted to the other for it. The Romans conquered Egypt as well as Greece, but we do not find that they adopted any of the peculiarities of Egyptian architecture. They carried away indeed the obelisks and many of the sculptures of Egypt, as trophies of their conquests or as ornaments of their city; but they neither made obelisks nor constructed temples to Egyptian divinities in the Egyptian style. If, however, Greek architects were employed by the Romans, they must have made their taste and mode of design conform to those of their conquerors much more readily than we can imagine they would as the civilized slaves of barbarian masters; and it is too clear to be disputed, that the Roman architecture is a style essentially distinct from the Greek. This is elucidated by the fact that many of the minor works of sculpture in connection with architecture, such as candelabra, vases, and various articles of household furniture discovered at the villa of Adrian, near Tivoli, and at Herculaneum and Pompeii, are fashioned and ornamented in the Greek style, while others are as decidedly Roman in those particulars; rendering it evident that such things were either imported from Greece, or that Greek artists and artisans were employed in Italy, who retained their own national taste and modes of design. It is probable, nevertheless, that both the architects and the artists, natives of Rome, qualified their own less elegant productions by reference to Greek models; but that the Romans derived their architecture entirely from the Greeks, may certainly be disputed.

Half the extent and magnificence of the architectural works of the Romans is attributable to their knowledge and use of the arch, which enabled them, as we have already intimated, to make small parallelopipedons of burnt earth more extensively applicable to useful purposes than any other material could be, from the greater cost of providing and preparing it; whereas brick can, in almost every place, be made on the spot in which it is wanted. There is a very false notion abroad as to the richness of the materials used for building in Rome, induced by the inflated accounts of travellers and poets, who attempt to disguise their ignorance, while they display it by filling Rome with what it never contained—marble temples, palaces, and baths. The truth is, that Rome was built, not of marble, nor even of stone, but of brick; for in comparison to the quantity of brick, it may be safely asserted that there is more stone in London than there was in imperial Rome. Almost all the structures of the Romans indeed were of brick—their aqueducts, their palaces, their villas, their baths, and their temples. Of the present remains, it is only a few columns and their entablatures that are of marble or granite, and two or three buildings of Travertine stone;—all the rest are brick. The Colosseum, the Mausoleum of Adrian, the Tunnel Sewer, the Temple of Manly Fortune, and the ancient bridges on the Tiber, are of Travertine stone; the remaining columns of the more splendid temples, the internal columns and their accessories of the Pantheon, the exterior of the imperial arches, and the cenotaphial columns of Trajan and of Antonine, are of marble: but the Imperial Mount of the Palatine, which holds the ruins of the Palace of the Cæsars, is but one mass of brick; the Pantheon, except its portico and internal columns, &c., is of brick; the Temples of Peace, of Venus and Rome, and of Minerva Medica, are of brick; and so, for the most part, were the walls of others, though they may have been faced with marble or freestone. The Baths of Titus, of Caracalla, and of Diocletian, are of brick; the city walls are of brick; so are the extensive remains of the splendid villa of Adrian, and those of

[1] Bordeaux *did*. A century and a half ago there existed at Bordeaux very considerable remains of a most interesting Roman edifice, of which no authentic record is preserved but a slight sketch by Perrault, the architect of the great front of the Louvre, who delineated it a few years before its destruction by the government, and who termed it one of the most magnificent and most entire of the Roman monuments then remaining in France. The editor of the new edition of Stuart's Athens, speaking of this, says, "on this occasion the reflection presents itself, that while the Turks are reprobated for appropriating the columns of ancient Athens, in their haste to raise a wall to defend their town from the predatory Albanians, here, in the vaunted age of Louis XIV. (in his kingdom and under his government, may be added) the finest production of ancient architecture in France was more recklessly demolished to make place for the fortifications of Bordeaux, deliberately constructed by Vauban; and no architect, either of the city or government, has preserved for posterity the details of so noble a monument." (*Antiquities of Athens*, new edition, vol. iii. p. 120.)

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the villa of Mecænas at Tivoli; the palaces of the Roman emperors and patricians at Baiæ and in other parts of Italy; and so, it may be said, are the remains of Herculaneum and Pompeii, for the houses in those cities are generally built of alternate double courses of brick, and courses of stone or lava. In most cases, at Rome and in the provinces, stucco formed the surface which received the decorations. From the above enumeration, it will appear how much more variously the Romans built than any of their predecessors in civilization did. In Egypt we find no indications of edifices of real utility or convenience, nothing but temples and tombs,—and in Greece there is but a small addition to this list; but in Rome are found specimens of almost every variety of structure that men in civilized communities require. Much of this also may be attributed to the knowledge they possessed of the properties of the arch, which may be considered among the most admirable and useful discoveries ever made in the practical applications of mechanical science. It entered into the composition of every structure, and made the rudest and cheapest material of more real value than the most costly. It not only superseded the use of long stone beams, but was constantly used in places where indeed joists of wood would have been much more convenient, giving support to the opinion that even the Romans were not skilled in the application of timber to their edifices; though, on the contrary, it is difficult to understand how Rome could become subject to such a dreadful conflagration as that which occurred in the reign of Nero, if timber had not been employed in the ordinary houses of the city to a much greater extent than would appear from existing remains. The domestic structures of Herculaneum and Pompeii were evidently never very susceptible of fire, from the small quantity of timber required in their construction; and discoveries which are made from time to time, of portions of the ordinary houses of ancient Rome, under the pavements of the modern city, evince that they were very similar to them in almost every particular. The infrequency of stairs, and the meanness of those which exist leading to upper apartments in the houses of those cities, induce the belief that the Romans seldom built above the ground story, and that their skill in carpentry was not very great; otherwise they would more frequently have had recourse to so easy and convenient a mode of extending room as upper stories offer. There are, however, other things which tend to prove that carpentry was well understood by the Romans; and the most remarkable is the bridge that Trajan built over the Danube, the piers of which are said by Dion Cassius to have been 150 feet high and 170 feet apart. Now, whether the bridge itself consisted of a wooden platform, as there is much reason to believe, or was of stone arches, as the historian intimates, the skill which constructed centring for the latter, or laid the platform from pier to pier in the former case, of that immense extent, was amazing; nevertheless, such skill in carpentry is not evinced by the remains of the civic and domestic structures of the Romans, in which arching in all its varieties was used where carpentry would have been better. Of their joinery we know nothing; but it does not appear, from the last-quoted mode of ascertaining such things, to have been much practised by them—mosaic pavements supplying the place of flooring, and stucco that of wainscoting: the luxury of windows being unknown, their fittings were not required; and doors, it would appear, were uncommon, except externally—the internal doorways being most probably covered with something equivalent to the quilted leather mats suspended from the lintel, which are used instead of swinging doors at the entrances of the churches in Italy at the present time. Although the Romans did not use marble to the extent that has been supposed, yet they were extremely luxurious in the use of costly stones. Marbles of every variety, and from all parts, were used in Rome; and columns were made of Egyptian and other granites, and of porphyry. In Greece, and the Grecian colonies which were conquered by Rome, the edifices of the Romans might be distinguished by the foreign marbles used in them, if the style of their execution were not sufficient otherwise to determine them.

The mingling of columnar and arcaded arrangements in the same composition appears to have been the grand cause of the deterioration of Roman architecture. It occasioned unequal and inordinately distended intercolumniations and broken entablatures: these a vitiated taste repeated, where the necessity that had first occasioned them did not exist; and harmony and simplicity being thus destroyed, the practice went on deteriorating until it was made to produce such monstrous combinations as the Palace of Diocletian at Spalatro, and the Temple of Pallas, or ruins of the Forum of Nerva in Rome, present. It was indeed a fall from the grandeur, harmony, and noble simplicity of the interior of the Pantheon in its pristine state, to the hall or xystum of the baths of Diocletian, which now exists as the church of Santa Maria degli Angeli, with its straggling columns and broken and imperfect entablature; or from the temple of Jupiter Stator to that of Concord or the arch of Septimius Severus.

Architecture as a fine art was already extinct among the Romans when the seat of empire was transferred to Constantinople; so that, however great were the extent and splendour of the edifices, we cannot suppose them to have possessed any of those qualities which give to the Parthenon at Athens, and to the interior of the Pantheon at Rome, the charm they possess; unless the Greeks had recourse to the monuments of their own country, and used them as founts from which to draw matter for the composition of the edifices of their new capital. This, indeed, is possible, for there appears to have been, even in Rome, at and after the time of Constantine, a recurrence to the ancient simplicity, though, truly, without any of that beauty and elegance of form in the details, and of proportion in the general arrangement, which constitute half the merit of works of architecture. The change of religion which took place under Constantine led to the destruction or destitution of many of the noblest structures in Rome. The ancient Christian basilicas are for the most part constructed of the ruins of the more ancient Pagan temples, baths, and mausoleums; and in them a much greater degree of simplicity, and consequent beauty, pervades the columnar arrangements than existed perhaps in some of the previous combinations of the same materials. Frequently, however, the collocation of various parts was most unapt; and gross inconsistencies were recurred to, to get rid of the difficulty of combining discordant fragments. Sometimes it was necessary to make up with new, what was wanting of old materials, whose forms were rudely imitated.

Gothic or Pointed architecture.

In those countries which received the Christian religion from Rome, but which did not contain mines of architectural material in temples, amphitheatres, and palaces, as Italy did, and indeed in the other parts of Italy itself which did not contain them as Rome did, churches were constructed in imitation of those of the metropolis of the Christian world. These, being the work of a semi-barbarous and unpolished people, were of necessity rude and clumsy. Hence arose the Gothic architecture of the middle ages, and not from any previously existing style of architecture among the northern nations who overran Italy and subverted the Roman power. The rude Celtic

monuments were the only specimens of architecture they possessed, and the performance of their unhallowed rites appears to have been long transferred even from them to the groves, or it may be that the stone circles and temples themselves were called groves. This, however, is of but little consequence to our purpose. The fact is indisputable, that nothing existed among those nations that could have given rise to the rude style of architecture referred to, which was indeed introduced to them by the Christian religion in the manner we have stated. It will be found in what are called the Saxon and Norman styles of this country, and to a greater or less extent in all the countries of Europe in which the Romans had been masters, and particularly in those which adhered to the Roman communion in the great division of the churches. The general forms and modes of arrangement peculiar to Roman architecture may be traced throughout; in some specimens they are more, and in others less obvious, but the leading features are the same. This is more evident in Italy than elsewhere. In the early Roman basilicas and churches, some of which are of the Constantinian age, and which were constructed with the matter and in the manner related, the first divergencies occur; in those which are later they are still greater, and distance of time and place appears still to have increased them, till what may be called a new style was formed, having peculiarities of its own, but yet more clearly deducible from its origin than Roman is from Greek or Greek from Egyptian. As might be expected, this style was not the same in all the countries which practised it; it was derived, in them all, from the same source as we have shown, but was materially influenced by the habits, manners, and state of civilization in which the various nations were, and much too by their means of communication with Rome. This, with strict propriety, may be called Gothic architecture, as it was partly induced by the Gothic invasions of Italy, and was most generally practised by the nations to whom that term may with equal propriety be applied. It arose in the fourth century, and was subverted in the twelfth by the invention or introduction of the pointed arch, which marks a new era, and was destined to give birth to a new style in architecture. Where, when, and with whom the pointed form originated, has been more discussed and disputed than the discovery of the properties of the arch itself. Some have contended that it was suggested by the intersections of semicircular arches, as they were employed in ornamenting the fronts of edifices in the preceding style; some, that groined arches of the same form gave the idea; others have referred it to the interlacing of the branches of trees when planted in parallel rows,—to an imitation of wicker-work,—to a figure used on conventual seals,—to the principle of the pyramid,—to Noah's Ark,—to chance. Its invention has been accorded to almost every nation, civilized and uncivilized. It has been claimed by Germans for Germany, by Frenchmen for France, by Scotsmen for Scotland, and by Englishmen for England. Italians have not directly laid claim to the honour for themselves, but it has been given them by others. Such a mass of conflicting opinions, almost all supported by some show of reason, and more or less by evidence, may be called a proof of the impossibility of determining the question, and therefore we shall not attempt it. There is one striking fact, however, which has been too much overlooked by many of the theorists in the discussion of the question; it is, that the pointed arch made its appearance almost at the same moment of time in all the civilized countries of Europe. This is proved by the controversies of those who, more patriotically than philosophically, claim its invention for their respective nations; for none of them can produce genuine specimens of it before a certain period, to which they can all reach. Now, if it had been invented in any of the European nations, that one would certainly have been able to show specimens of it of a date considerably anterior to *some* of the others; for though it might by chance have been soon communicated to any one of them, the improbability is great that it would immediately have reached them all, and have been at once adopted by all, to the subversion of their previously practised forms of construction. The infrequent and imperfect modes of communication between the different countries of Europe at the period referred to, furnish another reason why it is not probable that a discovery of the kind should travel rapidly from one to another. Considering these things, and particularly the fact of the almost simultaneous introduction of the pointed arch to the various nations of Europe, as it appears by their monuments immediately after the first crusade, in which they all bore a part, connected with existing evidence that it was commonly used in the East at and anterior to that period, it seems to be the most rational theory, that a knowledge of it was acquired by the crusaders in the Holy Land, and brought home to their respective countries by them. This, indeed, is the opinion of many of those who have written on the subject; and without contending that the evidence in its favour is quite conclusive, we think it more satisfactory than any other. In Europe there are found rude approaches to the pointed form in some of the earlier Gothic structures; but we believe it may be safely asserted, that nothing can be indicated of a date beyond that of the first crusade, approaching the simple but perfect lancet arch, which, it is not denied, came into use immediately after that period; whereas tolerably well authenticated examples of it are found in the East, of sufficient antiquity to induce the opinion that it was at that time imported from thence. It is, moreover, indisputable that the Saracenic or Mahometan nations do use, and have used, the pointed arch; but they were never known to adopt any European custom or invention of any kind till very lately How then can they be supposed to have availed themselves so readily as they must have done, if it be of European origin, of so unlikely a thing to attract a Moslem's attention, as the peculiar form and structure of an arch? and when and where in Europe had they an opportunity of contemplating it until long after it is known to have been in common use among them? With what nation of the East, and in what manner, the pointed arch originated, are points equally difficult to solve. We have not been able to discover that the properties of the arch were known to the Egyptians or to the Greeks, and there is no evidence to show that they were known to the Persians or to the Indians of ancient times; but structures are found in the countries of those nations in which chambers are domed, and apertures headed in the form of a pointed arch, produced, however, by gathering or corbelling over, and not by arched structure. It is not improbable, therefore, that such things being before the eyes of men, when the properties of the arch became known that form would be repeated upon it, and the result would be the lancet arch,—the prototype, the germ of the style. The pointed arch, on its introduction into Europe, does not appear to have been accompanied by its ordinary accessories in after-time; its light clustered pillars—its mullions, foliations or featherings, and graceful tracery—these resulted from its adoption: so that whether the arch itself was invented in Europe, or imported from the East, to the European nations must be assigned the credit of educing the beautiful style of architecture whose distinguishing feature it is.

It may be doubted whether Venice was not the parent of the style, for very early specimens of the pointed arch

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Before proceeding further with this subject, it is necessary to determine by what name to call the style whose progress we have yet to contemplate. There would be no greater propriety in calling it Saracenic because its distinctive feature originated in the East, even if that point were conceded, than in calling all architectural combinations which derive their character from the use of columns in them by the name of the nation in whose works we find columns first used, and from whom the idea of them may have been acquired. Neither can it with any degree of fitness be called Gothic: that term, we have seen, applies to the style that preceded it, and was first given to the pointed-arch style opprobriously, during the offuscation of good taste that succeeded its subversion. In Italy it had never taken root, as in the countries north of the Alps—the ancient Roman monuments having continued to influence the national architecture, it would appear, throughout the middle ages; for the ecclesiastical structures of that country, though rude, were never so rude as they were in other places, and a better style had so far formed itself before the introduction of the pointed arch, that it was hardly received there. Indeed, whatever edifices of merit Italy possesses in its manner, are, with hardly an exception, by German architects, few Italians having ever qualified themselves to practise it. When, therefore, what has been called "the revival of architecture" took place in the fifteenth century, under Brunelleschi and his successors, the rude structures of their own country, the precursors and contemporaries of our Saxon and Norman edifices, were called Gothic; but the style of which the pointed arch is the characteristic feature, was always distinguished as the German manner, *Maniera Tedesca*. The disgrace of applying the opprobrious term Gothic to it attaches itself to an Englishman, Sir Henry Wotton. It was continued by Evelyn, who applied it more directly; and the authority of Sir Christopher Wren finally settled its application. Its injustice is, however, rendered very obvious, by comparing the front of Pisa Cathedral, the best example, perhaps, of Gothic, or merely deteriorated Roman architecture, with that of York Minster, which holds an almost equal rank in the style of which it is an exemplar. The presence of the pointed arch, on the singular oriental-looking cupola of the former, shows it to be one of the latest edifices in its style, overtaken by that before it was completely finished. Within the present century a better taste has been formed, in this country particularly, and has led to the appreciation of that, which is, indeed, our national style; and within that period many attempts have been made to explode the universally-decried, unjust, and totally irrelevant appellation, but without effect. Sir Christopher Wren himself attempted to change it to Saracenic, believing that not merely the arch, but the style generally, was borrowed from the Saracens. It was, however, too late—he had already used the other. Dr Stukely wished to call it Arabian. Some writers called it Italian, others German, others Norman or French, others British, and many have contended for the exclusive term English; and to this last the Society of Antiquaries lent its influence, but with equal inefficiency, for the term Gothic still prevails. Mr Britton, than whom perhaps no man possesses a greater right to affix an appellation to the pointed-arch style, from the splendid services he has done it in the publication of his Cathedral and Architectural Antiquities, wishes to introduce a term which is not at all unlikely to succeed, as it is equally appropriate and independent of national feeling and hypothetic origin. He calls it Christian architecture. This, as a generic term, would admit each nation possessing specimens of it to distinguish its own species or style; and as the varieties of Hellenic architecture are known by the names of the tribes or nations who are presumed to have originated them—Dorian, Ionian, and Corinthian—so might Christian architecture be English or British, German, French, &c for each has its peculiarities. These species would again individually admit of classification, according to the changes each underwent in the course of its career. One strong objection, however, in our view of the case, lies to Mr Britton's distinctive appellation. It is, that "Christian" applies as well, if not better, to the real Gothic style—that which arose on the extinction of Roman architecture, and was subverted by the introduction of the pointed arch, and which, indeed, owed its diffusion and progress, if not its origin, to the Christian religion. We are therefore still left to seek an appellation; and, in the absence of a better, will use the term Pointed, which is not only distinctive, but descriptive; and it has, too, the merit of being general, so that it may mark the genus, while the national species and their varieties may be distinguished by their peculiarities as before.

Plate LXX.

The Pointed Arch was a graft on the Gothic architecture of northern Europe, as the circular arch of the Romans had been on the columnar ordinances of the Greeks; but with a widely different result. The amalgamation in the latter case destroyed the beauty of both the stock and the scion; while in the former the stock lent itself to the modifying influence of its parasitical nursling, gradually gave up its heavy, dull, and cheerless forms, and was eventually lost in its beautiful offspring, as the unlovely caterpillar is in the gay and graceful butterfly.

We have seen that architecture had its origin in religious feelings and observances—that its noblest monuments among the pagan nations of antiquity were temples to the divinity—that the rude nations of the north in the middle ages devoted their energies, after their conversion to Christianity, to the construction of edifices for the worship of the Almighty; and we find, again, that the most extensive and most splendid structures raised by the same people, when the light of learning had begun to shine upon them, and a new and more beautiful style of architecture was introduced, were dedicated to the same purpose. In addition, however, many, hardly less magnificent, and not less beautiful, were raised for the purposes of education, and became the nurseries of science and literature. Kings and nobles also employed architecture in the composition, arrangement, and decoration of their palaces and castles; but still, for domestic purposes, its aid was hardly required beyond the carving grotesque ornaments on the wooden fronts of houses in towns.

When the practice of building houses in stories commenced cannot be correctly ascertained; but it appears to have arisen during the middle ages. We frequently, indeed, find an apparent equivalent for the term *story* used by the ancient writers, both sacred and profane; but it must have reference to something else—some peculiarity of which we are not aware; for none of the ancient re-

mains, whether of public or private structures, give reason to believe that it was a common practice even among the Romans; much less was it likely to be so among the eastern nations, with whom the practice is not very general, nor is it carried to great extent even at the present day. Indeed, without considerable proficiency in the art of construction, it is hardly practicable to build in stories with such slight materials as were used by the Romans in their domestic edifices; and their remains do not evince the requisite degree of proficiency. We find, however, in the oldest existing works of the middle ages, and particularly in some of the secular structures of Venice which are among them, a degree of intelligence evinced in that respect far surpassing any thing in those of the ancients. Possibly the skill was principally acquired in that city from the necessity of making artificial foundations, which consequently required a superstructure not unnecessarily cumbrous; and again, to make slight walls sufficiently strong, they must be skilfully bonded in themselves, and bound together, which could only be done by means of a material possessing considerable length and great fibrous tenacity—whence framed floors of timber. These, by their strength, their obvious utility and convenience, added to the want of space which existed in a thriving and populous community on a very restricted spot of dry land, superinduced, in the second place, the building of additional stories, which would soon be imitated in other places. But in what manner soever the improvement took place, the fact is certain that the acquisition was made; and we find it applied in all the works of the European nations, both ecclesiastical and civil, from the ninth and tenth centuries downwards. The combination of masonry and carpentry in building tended greatly to the advancement of both; for, it being required at times to make them act independently of each other, additional science and art were necessary, as the proportions must be retained that were given to similar works in which they co-operated. Hence the wondrous skill evinced in the vaulted roofs and ceilings, in the towers and lofty spires, of some of our Pointed cathedrals for the one, and the splendid piece of construction in the roof of Westminster Hall for the other. To this point Sir William Chambers, who was no depreciator of the merits of the Romans in architecture, says, "In the constructive part of architecture the ancients do not seem to have been great proficients:"[1] then having referred many of what he calls the "deformities observable in Grecian buildings" to want of skill in construction, he continues, "neither were the Romans much more skilful; the precepts of Vitruvius and Pliny on that subject are imperfect, sometimes erroneous, and the strength or duration of their structures is more owing to the quantity and goodness of their materials than to any great art in putting them together. It is not, therefore, from any of the ancient works that much information can be obtained in that branch of the art. To those usually called Gothic architects we are indebted for the first considerable improvement in construction. There is a lightness in their works, an art and boldness of execution, to which the ancients never arrived, and which the moderns comprehend and imitate with difficulty. England contains many magnificent specimens of this species of architecture, equally admirable for the art with which they are built, the taste and ingenuity with which they are composed." To this Mr Gwilt, in his new edition of Sir William's work, adds in a note, "there is more constructive skill shown in Salisbury, and others of our cathedrals, than in all the works of the ancients put together."

Pointed architecture took root and grew with the greatest vigour in Germany and Great Britain, and in those provinces, principally, of France which were connected with England; but in this country its course is the most marked, and its advances are the most easily traceable. We find in various portions of the same edifice, according to the period of its construction, exemplifications of the style, from the ingrafting of the simple lancet arch on the Norman or Gothic piers in the time of Henry II. to the highly enriched groinings and ramified traceries of the age of Henry VII.; but the changes are so gradual, and are so finely blended, that the one in advance appears naturally to result from that which comes before it. Whether the nations of the Continent, then, borrowed from us, or were themselves originators, it is very clear that we did not borrow; for our structures bear the strongest possible marks of originality, as the advances can be traced from one thing to another on them; and such is not so completely the case with theirs. Moreover, the latest manner, and certainly not the least beautiful, the Corinthian order of Pointed architecture, is almost peculiar to this country. Neither Germany nor France can produce edifices in the style of St George's Chapel at Windsor, King's College Chapel at Cambridge, and Henry VII.'s Chapel at Westminster. The structures of Scotland in the Pointed style so much resemble those of England, that they must be considered of the same school; Roslin Chapel is one of the few specimens which indicate a connection with the Continent. Ireland contains but few examples in any degree of perfection, and they are, of course, of the English school. The German school was next in merit to the English in the practice of Pointed architecture. In the extent and magnificence of its attempts, perhaps, that country excelled; but few of the great structures in Germany were ever completed. In regularity, however, they have generally an advantage over those of England, being mostly in the same manner throughout, as far as they were carried; whereas few of the greater edifices of this country were begun and completed without considerable variations in the style. But the Germans were never so successful in the splendour and beauty of their interiors as the English; indeed in that particular our Pointed structures are strikingly superior to every other: nor is their ornament generally so effective as ours. The Flemish style of Pointed architecture is hardly a variety of the German, but may be classed with it through the whole course of its history. Italy, we have said, possesses but few structures in the Pointed style, and they are for the most part the work of German architects, which their appearance indeed bespeaks. Milan cathedral, or "the Duomo," as it is called, is the most renowned edifice in the style that Italy contains; but it has few beauties in the eyes of those who are accustomed to the models of Great Britain, France, and Germany. The Patriarchal Church of St Mark at Venice is a genus *per se*. It was constructed by a Constantinopolitan architect in the ninth or tenth century, and may be a specimen of the architecture of the Byzantine capital at that time. The few examples in Sicily of the pointed arch may be attributed to the Norman conquerors of that island; and so indeed may most of those which are found in the continental part of the same kingdom. Although France contains many fine specimens of Pointed architecture, it can hardly be considered indigenous to that country. On the German frontier they resemble the German style; and in the provinces which were formerly connected with England they are different, and more like the English styles: cer-

[1] Gwilt's *Chambers's Civ. Arch.* p. 128.

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tain it is, that after their connection with this country was broken off, its practice fell into disuse, and nothing of consequence in it was posteriorly produced in any of them. This fact is an argument against the presumption that England was indebted to Normandy and Norman architects for its improvements in Pointed architecture; it tends rather to prove the opposite. It must be confessed, moreover, that there is an air of cumbrous massiveness in the Pointed style of Normandy which renders it peculiar, and perhaps marks its more close relationship with the earlier Norman Gothic. Like the German examples, too, those of France are generally inferior in internal richness and beauty to those of England. Pointed architecture in Spain never acquired that degree of consistency and elegance which might justify us in speaking of the Spanish specimens of it as forming a style. The edifices in Spain of the ages of Pointed architecture are more in accordance with the Moorish than with the European manner, and may perhaps be more correctly considered as an off-shoot of the former than of the latter. Though not in the Pointed style, the Moorish or Saracenic structures in Spain may be referred to here. They are in a very peculiar manner, which, it would appear, their authors brought with them from the East. Probably it grew out of some of the earlier styles of architecture, as the Gothic and Pointed did out of the Roman, and was not the result of design. The really distinctive feature of the Saracenic style is the horse-shoe arch, which is the greater segment of an ellipsis, nearly, on a conjugate chord. The columns from which the arches are sprung are slender, and the superincumbent masses are broad and heavy, giving an air of the intermingling of Chinese and Egyptian, both of which this style may be said to assimilate. The enrichments of Saracenic architecture are very much confined to flat surfaces, the walls being sculptured all over with monotonous ornaments, which produce an effect very similar to that produced by the hieroglyphics on the flat surfaces of the Egyptian temples, and possibly were derived from them. The most distinguished monument of this style in Spain is the Alhamrā at Granada. The most distinguished specimen of Pointed architecture in Portugal is the church of the convent of Batalha, which was constructed by an Irish architect, who appears to have modified the style of his own country (the English), by the manner of the country itself, which is nearly that of Spain.

What the expansive dome is to Roman architecture, the graceful spire is to Pointed. Bell-towers appear to have been added to Christian churches at a very early period; but it is much to be doubted whether the pyramidal pinnacle or spire was ever used before the introduction of the pointed arch, though one or two doubtful examples exist. These, certainly the earliest specimens of it, are simple cones, whose vertical bisection would be nearly an equilateral triangle: the angle at the apex was gradually made less, and as it diminished the altitude was increased, till at length resulted an object even more beautiful than an Egyptian obelisk, which would of itself indeed be a sufficient warranty for the appellation we have given to the style that it crowns. The spire was at first round, solid, and unornamented; it then became polygonal, and finally octagonal, though there are examples of square spires. They are sometimes plainly ribbed, sometimes crocketed, and in some instances pierced; and in the finer examples are almost invariably surmounted by a rich finial in the style of ornament peculiar to the time of its execution. In some cases the whole structure is a pyramis or spire, but most commonly the spire rests on a rectangular and upright tower. The Rev. W. L. Bowles has suggested that the spire was at first built on the bell-tower as a beacon or land-mark for the guidance of the traveller and the distant parishioner; and adduces as evidence, the fact, that in the hilly parts of England spires are hardly to be found except in modern churches. The old village church on a hill has a plain square tower, merely consisting of about two cubes, which can be seen at the greatest distance the nature of the country will allow any object to be distinguished; whereas in the level parts of the country, where a low tower would be lost amidst the foliage of its own churchyard, and be completely indistinguishable at a very short distance, spires are their almost invariable accompaniment. It may be added, that the tapering spire is almost unknown in Italy, and in France it is frequent only in Normandy; but in no part of the Continent is it so common as it is in this country.

We have already given our reasons for thinking that the pointed arch originated in the East; but whether it did or did not, it has been very extensively used in various parts of Asia, and nowhere in more sumptuous edifices, or to such effect, as by the Mohammedan conquerors of India in various parts of that country.

Italian school of architecture.

The opening of the Italian school of architecture on the resuscitated dogmas of Vitruvius was the signal for the extinction of that of the beautiful Pointed style. Fortunately, however, its effects were a full century in reaching this country, and during that period many of our most elegant structures came into being; and many of those of earlier date which had been commenced before, or during the wars of the Roses, and left unfinished, were completed. The first indication we have of the presence of the *Cinquecentist*, the real Goth, is in the tomb of Henry VII., which was executed by Torregiano, an Italian artist, who, it would appear, was obliged to have some respect to the style of the edifice in which his work was to rest; but his preconceived ideas of propriety and beauty were too strong to allow him to omit the characteristics of his school, and the result is a strange mixture of both. From that time the Pointed style was rapidly deteriorated, being overborne by the devices of Italy. On the Continent the latter were already predominant, for during the whole of the fifteenth century the current had been setting from Italy over every part of Europe which received its religion from Rome; and this country was only the last to be overwhelmed by it. Before quitting the part of the subject having reference to our national style of architecture, it may be well to controvert the absurd but too prevalent idea, that we are indebted to foreigners, and particularly Italians, for the excellence of our ancient works. After what has been already said, perhaps it may be unnecessary to do so here, seeing that we have described our specimens of the Pointed style as being not only fully equal in composition, construction, and execution to those of any other country, but as being absolutely in a different manner, having peculiarities which no other nation has ever equalled in beauty and elegance. But, to put the case in a clear point of view: If foreigners were employed to design and execute for us, it is not less strange that they should surpass their own works at home, than that they should make inventions and improvements for us (or let them be called mere variations) which were not in turn executed in their own countries. We know very well that works of architecture and sculpture which have been executed by foreigners in this country, since the explosion of Pointed architecture, are in the style of Italy or France, and not according to the manner prevalent in this country at the time of their execution. Moreover, for one whole century this nation alone adhered to the Pointed style, during which works were produced, that, for originality, exuberance of fancy, and beauty, spirit, and excellence of ex-

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If the architecture of Italy never fell away so much from the more classic style of Imperial Rome as that of the northern nations did, neither did the Italians ever possess that more than equivalent, whose splendid course we have last noticed. Whilst the Pointed style was almost exclusively known and practised in Germany, France, and the British Islands, the Italians were gradually improving on their Gothic style; yet the improvement was more evinced in their secular than in their ecclesiastical structures. Florence, Bologna, Ferrara, Venice, and many other cities of Italy, contain palaces and mansions of the twelfth, thirteenth, and fourteenth centuries, which for simplicity and classical beauty far excel most of those in the same and other places of the three subsecutive centuries. The contemporary churches, however, do not exhibit the same degree of improvement, forming, as it were, an anomaly in the history of architecture; a change in it being first developed in secular structures, and then applied to those devoted to the worship of the divinity; for many of the churches of the fifteenth century are in this, which may be called the early Italian style, or *Trecento*, as that which followed it is known as the *Cinquecento*.[1] Circular arches, and plain continuous horizontal cornices, and pilasters but slightly projected, with simple but generally tasteful and elegant enrichments of foliage and carved mouldings, are the most striking characteristics of the *Trecento;* but columns, and the arrangements depending on them, except as collocated with pilasters, are very infrequent in it. In various parts of Italy, and particularly in Venice and some of the Venetian cities, this style produced many of its best works, both secular and ecclesiastical, even during the fifteenth century; but it gradually gave way to, though in some instances its influence may be traced even when it had been overborne by, the new style.

The first step taken towards the reformation of architecture was by Filippo Brunelleschi, a Florentine architect, who was employed to finish the cathedral or duomo of his native city early in the 15th century; a work which had been commenced more than a century before on the design of Arnolpho, a Florentine also, but which still required the cupola when its completion was intrusted to Brunelleschi. The edifice is in the Italian Gothic style, slightly modified by what we have termed the *Trecento*, which his superior taste and talent induced him to attempt to supersede, and bring the world back to the classic style of ancient Rome. The construction of the cupola gained him great reputation and the confidence of the public, which he employed to advance his favourite scheme. To use the words of an Italian writer on the subject, "On the example of so wise and skilled a man, other architects afterwards devoted themselves to free architecture of the monstrosities introduced by barbarism and excessive license, and to restore it to its primitive simplicity and dignity."[2] But to what did they have recourse to effect this? Did they examine and study the remains of antiquity in Greece and Rome, in Italy and elsewhere? No! they referred to the writings of an obscure Latin author, who professed to give the principles and practice of architecture among the Greeks and Romans, but paid no more attention to the existing architectural works of those nations than if they had never been, although one could hardly walk the streets of any of the old cities in the south of Italy without seeing Roman edifices, whilst Rome and its vicinity was, as it still is, full of them. All the use, however, that these self-called "restorers" of architecture made of the works of the ancients, was to use them as lay-figures, or frame-work, to model on, according to the proportions and directions given by Vitruvius; and the effect was formality and mannerism in those who adhered to the dogmas of the school, and wild grotesqueness in those who allowed themselves to wander from them, whilst simplicity, and its consequence good taste, were effectually banished from the works of them all. History.

It will be necessary here, perhaps, before we advance further in our remarks on the Italian school, to disabuse the public mind as to the merit of the works of Vitruvius, whose anilities have so long passed for authorities, that a writer would be suspected of prejudice who spoke of them slightingly without adducing reason and evidence to prove them valueless; except, indeed, as records of the architectural practice, and the opinions and acquirements of an architect of a distant age. It is of very little consequence that Vitruvius is only known by his own writings, but that mention of him by a contemporary or other ancient author would probably determine the age in which he lived. From several things he mentions, and his inscription or dedication to the "Imperator Cæsar," it has been concluded that he lived in the time of Augustus; but certainly without sufficient reason; for if the man he speaks of as the son of Masinissa had been the son of the celebrated Numidian of that name, in the course of nature neither he nor Vitruvius could have lived to the time of Augustus. But he addresses an emperor who succeeded his father an emperor, and speaks of a temple of Augustus; so that he must have been a contemporary of some period of the empire. If that period had been the Augustan, he would doubtless, have made some reference to some of the many distinguished men of that age, or have been referred to by some of them if he had himself been at all known or distinguished as his admirers insist he was; neither of which is the case; and, moreover, his language is not that of an educated man of the Augustan age. This, however, does not affect the merit of his work as a treatise on architecture; but his fables about the origin of building, the invention of the orders, and the arrangements which grew out of certain modes of construction, do so; by proving his total ignorance not only of the architectural works of the more ancient eastern nations, but of those of Greece itself, which he professes to describe. Now his classical taste, in consequence of his knowledge of antiquity, is vaunted by Perrault, one of his commentators, and given by him as a reason why Vitruvius was not much employed by the whimsical Romans in their love of variety, to which he would not administer. How far his knowledge of antiquity, that is, according to himself, of the works of the Greeks, extended, may be readily determined by comparing the designs of Greek structures, made by Perrault and others, according to the directions of Vitruvius, with the Greek structures

[1] *Cinquecento* means literally *five hundred*, but it is used as a contraction for *fifteen* hundred, or rather for *one thousand five hundred*, by the omission of *mille*, the century in which the revival of architecture, of which we are about to speak, took place; and the manner consequent is so designated. *Trecento* would be *three* hundred, or the *third*, for the thirteenth century.

[2] *Le Fab. e i Disegni di A. Palladio* da O. B. Scamozzi, tomo i. p. 4.

themselves as they exist at the present time, and are faithfully delineated in various modern works, but especially in Stuart and Revett's *Antiquities of Athens.* It is indeed not less strange than true, that not a single example of Greek architecture will bear out a single rule which Vitruvius prescribes, professedly on its authority; and not an existing edifice, or fragment of an edifice, in form or proportion, is in perfect accordance with any law of that author, nor indeed are they generally referable to the principles he lays down. Examples might be cited almost to infinity in support of this statement, and to prove the inutility of a work consisting of mere descriptions without delineations, even if it were otherwise correct. The latter may certainly be supplied from the ancient remains when they exist; but to a man in possession of the specimens, descriptions and directions for their composition are quite unnecessary. Even Sir William Chambers, a distinguished disciple of the Italian or Vitruvian school, speaks very lightly of the advantage to be gained from the study of the Vitruvian principles of construction; and Mr Gwilt, in the introductory treatises to and notes on Sir William Chambers's work, has done much to undermine the authority, by exposing the absurdities and fallacies of the Magnus Apollo of pseudo-classical architecture. A student would acquire as correct a knowledge of history and geography from the Seven Champions of Christendom and Gulliver's Travels, as of architecture from the text of Vitruvius!

The adoption of the Vitruvian laws by the Italian architects of the 15th century led to the formation of the "Five Orders." It will have been observed that, in speaking of the course of Greek and Roman architecture, the Doric, Ionic, and Corinthian styles were mentioned. Vitruvius describes, in addition to these, another, which he calls Tuscan—possibly a style of columnar arrangement peculiar to Italy, and most likely of Etrurian origin; but, in the absence of delineations, the *Cinquecentists* could only apply the proportions he laid down for it, to what appeared to approximate them in the ancient remains; and hence arose a fourth, or "the Tuscan Order." It is, however, a mere modification of the Roman debasement of the Doric, and may be considered, in its present form, as of purely modern Italian origin. The same "Revivers," on looking among the ruins of ancient Rome for the forms of their Vitruvian orders, found specimens of a foliated ordinance, which the bad taste of the Romans had compounded of the foliated and voluted styles of the Greeks. This was seized upon as a fifth style, subjected to certain rules and proportions, and called "the Composite Order." The very poor Roman specimens of Doric and Ionic fitted themselves without much difficulty to the Vitruvian laws; but the examples Rome afforded of the Corinthian were less tractable, and being as various as they are generally beautiful, they were all passed over, and their places supplied by a mere changeling—an epitome of the Vitruvian theory. Thus we have the "Five Orders" of the Italo-Vitruvian school, and in this manner they are arranged: *First,* the Tuscan, of which there is no recognised example of antiquity, but which owes its form to the descriptions of Vitruvius and the fancies of the revivers; *second,* the Doric, a poor and tasteless arrangement of the general features of the style on a Roman model; *third,* the Ionic, which is almost as great a debasement of the Grecian originals, and was produced in the same manner as the last-mentioned; *fourth,* the Corinthian, a something totally unlike the ancient examples of both Greece and Rome in beauty and spirit; and, *fifth,* the Composite, an inelegant variety of the Corinthian, or a hybrid mixture of the horned or angular-Ionic volutes, with a deep necking of the foliage of the preceding order.

The first to publish this system was Leon Battista Alberti, a pupil of Brunelleschi. He has been followed by many others, the most distinguished of whom are, Palladio, Vignola, Scamozzi, Serlio, and De Lorme, architects; and Barbaro, a Venetian prelate, and an esteemed translator of, and commentator on, Vitruvius. None of these, it must be understood, agreed with any other of them, but each took his own view of the meaning of their common preceptor; and yet none of their productions evince the slightest approach to the elegance of form and beauty of proportion which distinguish the classic models of the columnar architecture of antiquity. Palladio and Serlio were the first to publish delineations and admeasurements of the Roman architectural remains in Italy; but the total absence of verisimilitude to the originals, and, in many cases, the absolute misrepresentations, in both works, prove how incompetent the authors were to appreciate their merits; and the exaggeration of their defects proves with equal clearness the general bad taste of the school in which they are masters. The worst qualities of the Roman school of architecture were embraced and perpetuated by the *Cinquecento.* The inharmonious and unpleasing combinations which arose out of the collocation of arches with columnar ordinances became the characteristics of the Italian: unequal intercolumniations, broken entablatures, and stylobates, enter alike into the productions of the best and of the worst of the *Cinquecento* architects. The style of this school is marked, too, by the constant attachment of columns and their accessories to the fronts or elevations of buildings; by the infrequency of their use in insulated (their natural) positions to form porticoes and colonnades; by the thinness or want of breadth in the smaller members of their entablatures, and the bad proportion of the larger parts, into which they are divided, to one another; by the general want of that degree of enrichment which fluting imparts to columns; by the too great projection of pilasters, and the inconsistent practice of diminishing, and sometimes fluting them; by the use of circular and twisted pediments, and the habit of making breaks in them to suit the broken ordinance they may crown; and by various other inconsistencies and deformities, which will be rendered more evident when we come to treat of the style in detail. The merit of the Italian school consists in the adaptation and collocation of the prolate hemispheroidal cupola, which appears to have grown out of its opposite in the Roman works during the Gothic ages, as we find it in the early cathedrals; though it is highly probable that the idea was brought from the East, in the forms exhibited by the cupolas of St Marks at Venice, and of Pisa Cathedral. A very noble style of Palatial architecture also was practised by many of the Italian architects. It consists of the use of a grand crowning cornice, running in one unbroken line, unsurmounted by an attic, or any thing of the kind, superimposing a broad, lofty, and generally well-proportioned front, made into graceful compartments, but not storied, by massive blocking courses and other things, which are at the disposal of the judicious architect. Not unfrequently, however, the faults of the school interfere to injure a composition of this kind; for, to produce variety in the decorations of the windows, some of them have been made like doors, with distyle arrangements of columns, surmounted by alternations of circular and angular pediments, and sometimes with all the vagaries which deform the front of an Italian church. It is indeed the ecclesiastical architecture of the school in which its faults are most rife and its merits most rare. An Italian church possesses nothing of the stern simplicity and imposing grandeur of an Egyptian sacred structure—nothing of the harmonious

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beauty and classic dignity of a Grecian fane—nothing of the ornate and attractive elegance of a Roman temple—and nothing truly of the glittering grace and captivating harmony of a Pointed cathedral. No other style of architecture presents so great a contrast, in any two species of its productions, as the Italian does, in one of its ordinary church fronts, with the front of a nobleman's mansion or palazzo, in the manner already referred to; and in no city of Italy is the contrast so strong, by the egregiousness of the examples it contains of both, as Rome. The stately portico is hardly known in Italian architecture; and in the rare cases in which insulated columns are found, they are for the most part so meagre in themselves, and so thinly set, according to the Vitruvian laws, that the effect produced by them is poor and wretched in the extreme. This applies most particularly to Italy itself: in some other countries, and especially in this, those architects who have been of the Italian school have generally preferred the proportions and arrangements which they found in the Roman examples of antiquity, to those laid down by their Italian masters. Still, Italian church architecture boasts the cupola,—certainly its redeeming feature; and the architects of Italy must have full credit for the use they have made of it, both internally and externally. Perhaps no two edifices display more, and in a greater degree, both the merits and defects of the school which produced them, than the Farnese palace and the basilica of St Peter in Rome. The principal front of the former edifice is exquisite in its proportions, but frittered in its details. It has an immense crowning cornice, whose general effect is surpassingly grand; but the mouldings are too much projected, and its vertical parts want the breadth which the blocking courses possess. The lowest of its three tiers of windows is characterized by the most charming simplicity and good taste in almost every particular; but the other two are crowded with sins against both those qualities, in the dressings of the windows. The cortile and back front, though both very differently arranged from the front, and from each other, are not less filled with contrarieties; and so of the structure throughout. The front of St Peter's is not more distinguished by its magnitude than by its littleness and deformity. It contains the materials of a noble octaprostyle, and consists of an attached tetrastyle. It is divided into three unequal stories, within the height of the columns, whose entablature is surmounted by a windowed attic. In length it is frittered into a multitude of compartments, between which not the slightest harmony is maintained; while tawdriness and poverty are the distinguishing characteristics of its detail. A total absence of every thing which produces grandeur and beauty in architecture, marks, indeed, the whole of the exterior of the edifice, except the glorious cupola, than which architecture never produced a more noble and magnificent object. Internally, the structure is open to similar praise and similar dispraise. Gorgeousness in matter and meanness in manner characterize the interior of St Peter's, except the sublime concave which is formed by its redeeming feature without.

Plates LXIV. LXV. and LXVI.

The *Cinquecento* architects of Italy were exceeding mannerists: but besides the manner of the school, each had his own peculiarities; so that there exists in their works what may almost be called monotonous variety. Brunelleschi's designs are distinguished by a degree of simplicity and comparative good taste, which causes regret that he had not referred more to the remains of antiquity in Italy, and sought out those of Greece, and less to the dogmas of Vitruvius; for then his works would have been more elegant than they are, and the school he founded would have done him much more honour than it does. The works of Bramante possess a more classical character than those of any other architect of the school. Bramante's design for St Peter's was preferred by Pope Julius II. to a great many others by the most esteemed men of the time. He it was who suggested the cupola; but, unfortunately, after his death men of less taste and talent were allowed to alter the design, and the edifice has resulted very differently from what it would have done had Bramante been adhered to. This we judge from his works generally, and not from any positive knowledge of the design, which indeed does not exist. The elder Sangallo was far inferior to his contemporary and rival Bramante, and his works are full of the faults of the school. Michel Angelo Buonaroti was a man of great genius, but of coarse taste in architecture; and to him may be attributed many of the coarser qualities of the Italian style. His principal works are the buildings of the Capitol, and the College della Sapienza in Rome, and the Laurentian Library at Florence; and these are all distinguished for their singular want of architectural beauty and propriety in every particular. Michel Angelo was the Dante of Italian painting, but the Berni of its architecture. Raffaelle, too, had a very bad style in architecture, and so indeed had almost all the painters who professed to be architects also. They generally carried to extremes all the faults of the school. Sansovino and Sanmichele were men of considerable talent: their works display more originality and less servility than those of most of their contemporaries. Peruzzi was less employed than many who had not half his merit: his productions are with reason considered among the most classical of the Italian school. Vignola had a more correct taste than perhaps any other Italian architect of the 16th century: his works are indeed distinguishable by their superiority in harmony of composition and in general beauty of detail. Palladio very much affected the study of the antique, but his works do not indicate any appreciation of its beauties. He appears to have been very well qualified by nature for an architect, but spoiled by education. He did not look at the remains of antiquity with his own eyes, but with those of Vitruvius and Alberti, and he seems to have been too much influenced by the admired works of some of his predecessors. Palladio made greater use of insulated columns than the Italian architects generally, but his ordinances are deficient in every quality that produces beauty; his porticoes may be Vitruvian, but they certainly are not classic; and all his works evince that he studied the Colosseum, the Theatre of Marcellus, and the Triumphal Arches, more than the columns of Jupiter Stator and Mars Ultor, the Temple of Antoninus and Faustina, the Pantheon, the Portico at Assisi, and the other classic models, which he drew, but clearly did not appreciate. His columns upon columns, his attached and clustered columns, his stilted post-like columns, his broken entablatures, his numberless pilasters, straggling and unequal intercolumniations, inappropriate and inelegant ornaments, circular pediments and the like, are blemishes too numerous and too great to be passed over because of occasional elegance of proportion and beauty of detail. Scamozzi did not improve on the style of his master, which, however, he very much affected. Indeed the term *Palladian* has long been in general use throughout the civilized world for beautiful and excellent in architecture, so that it cannot be wondered at that Palladio's pupils and successors should imitate him; nor is it surprising that they did not surpass, or even equal him, for they were taught to look to his works as the *ne plus ultra* of excellence. Giacomo della Porta, a contemporary of Palladio, followed Michel Angelo in several of his works, and imbibed much of his manner, on which

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he certainly improved; but still his own is far from being good; Della Porta was much employed in Rome; and it fell to him, in conjunction with Domenico Fontana, to put the cupola on St Peter's. Fontana's style of architecture is not particularly distinguished for its good or bad qualities; he obtained more reputation as an engineer than as an architect, having been engaged in removing and setting up most of the obelisks which give so much interest to the architectural scenery of Rome. The Lunghi, father, son, and grandson, the Rainaldi, Maderno, Borromini, Bernini, Carlo Fontana, Fuga, Vanvitelli, and many others in the course of the seventeenth and eighteenth centuries, carried the peculiarities of the Italian school to the greatest extremes. Of those enumerated, Bernini was perhaps the least offensive, and Borromini the most extravagant; but throughout that period, except in extreme cases, individual manner is less distinguishable, and that of the school more strongly marked.

It may be gathered from the preceding remarks, that the secular architecture of the Italian school is generally preferable to the ecclesiastical, and that the architects of the fifteenth and sixteenth centuries were generally superior to those who followed them. In Italy the school has not yet ceased to exist, nor indeed has its style ceased to be studied. Designs are still made by the students of the various academies in the manner of the *Cinquecento*, and on the models with which the country abounds. The precepts of Vitruvius are yet inculcated, and the works of the men whose names we have mentioned are looked up to as master works of architecture in the country which contains the Roman Pantheon and the Greek Neptunium, besides the power of referring to the more exquisite works of Greece herself.

Influence of the Italian school.

In the fifteenth century such was the reverence of men for the revived works of ancient literature and science, that the profession of the Italians, that they had restored ancient classical architecture on the precepts of an architect of the Augustan age, was sufficient to open the way for them all over civilized Europe. In the course of that and the following century Italian architecture was adopted and Italian architects employed in France, Spain, Germany, Great Britain, and their respective dependencies; and now, in the nineteenth century, Vitruvius and Palladio are as predominant on the shores of the Baltic as on those of the Mediterranean Sea; though in this country and in some parts of the Continent their influence is considerably diminished since the time of Inigo Jones and Claude Perrault. It has been already remarked, too, that the *Cinquecento* was later in gaining a footing here than on the Continent, in consequence of the existence of a beautiful national style of architecture, which our ancestors do not appear to have been induced to resign to the barbarian innovators of the South, as readily as the interjacent nations were to give up theirs; for which indeed the reason exists in the greater attractions of ours, and the consequent greater difficulty of inducing the nation to part with it. The French, though they received the Vitruvian architecture from the Italians, were patriotic enough, as soon as they had acquired its principles, to confine the practice of it almost entirely to native architects, in whose hands it assumed a different character from that which it possessed in Italy, and became what may be called the French style of *Cinquecento*. Its ecclesiastical structures are less faulty than are those of the corresponding period in Italy, but its secular edifices are as far inferior to those of that country. The grand palatial style, which is exemplified in the Farnese palace in Rome, never found its way into France; but instead, there arose that monstrous and peculiarly French manner, of which the well-known palaces of the Tuileries and Luxembourg are egregious examples. In the age of Louis XIV. the French appear to have reverted to the Italian manner in a certain degree; for the palace of Versailles includes almost all the extravagancies of that school in its worst period, and contains moreover architectural deformities which Italy never equalled till it imitated them. They consist in the style of enrichment which is distinguished by the name of that monarch in whose reign it had its origin, and of whose gross taste and vulgar mind it is an apt emblem. The same period produced one of the most classical architects of the French school—its Palladio or Inigo Jones, Perrault, whose design for the buildings of the Louvre was preferred to that of Bernini, though indeed the preference was no compliment to the one nor discredit to the other, considering to whom the decision was of necessity referred. The Hôtel des Invalides is of the same age: it exhibits the graces of the Italian cupola, surmounting a composition which includes more than all the faults of St Peter's in Rome. The church of Sainte Genevieve, or the Pantheon, a work of the following reign, was intended to be in the ancient Roman style, and of Roman magnificence; but it is rather papally than imperially so. Ancient Rome was regarded in the columnar ordinance, but modern Rome in the architectural composition. In it the ecclesiastical style of the *Cinquecento* is commingled with the simple beauties of Roman architecture, almost indeed to the destruction of the latter: to this structure also there is a handsome cupola. Of late years the works of the ancients have been studied by the architects of France, greatly to the amelioration of their style; as yet, however, they are but imperfectly acquainted with the peculiarities of the Greek, and many of them still appear to retain their devotion to Vitruvius and the fifteenth century. Spain servilely received the Italo-Vitruvian architecture, and to the present day knows no other. Less patriotic than the French, the Spaniards have for their greatest works employed the architects of France and Italy. The Escurial, though the work of a native architect,[1] does little credit to Spanish art. The Italian Revival was the means of extinguishing the Pointed style of architecture in Germany, and certainly without affording it an equivalent. Italian architects were employed in Germany, and Germans acquired their manner; but they did not improve it, nor did they make it productive of so many good effects as the Italians themselves did. The change in religion which supervened the change in architecture in so large a part of Germany, may have tended to prevent the latter from acquiring that degree of exuberance there which it did in Italy; but even in Catholic Germany the splendid Pointed cathedrals have never given way to modifications of the pseudo-classic St Peter's. In the use of *Cinquecento* architecture for secular structures, it may be truly said that the Germans have not excelled the Italians; nor, on the other hand, have they equalled them in the absurdities and extravagancies which are so frequently observable in the works of some of the latter. The Germans also have lately turned their attention to the works of the ancients, and the fruit of it is already evident in many parts of the country, and most particularly in Prussia: still, however, they appear to have yet to learn the right use of the Greek models, and a proper sense of the exquisite perfection of their detail; as well as to emancipate themselves from many of the trammels of the Vitruvian school. The northern continental nations have been dependent on Germany, France, or Italy for their architecture, and can produce nothing that gives them a claim to our consideration in such a review as the

[1] It has been sometimes erroneously attributed to a Frenchman. The work was begun by Juan Bautista de Toledo in 1563, and completed by his pupil Juan de Herrera in 1584.—*Descripcion del Escorial* por Francisco de los Santos; *Viage de España* por Antonio Ponz; *Varia Commensuracion* de Juan de Arfe; Laborde, *Itin. Descrip. de L'Espagne*, t. iii.; Townsend's *Spain*.—Ed.

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present. St Petersburg is exclusively the work of architects of the nations just enumerated, and presents a mass of the merest common-places of Italian architecture, in structures calculated by their extent, like Versailles, the Escurial and St Peter's, to impose on the vulgar eye.

We have already more than once had occasion to refer incidentally to the introduction of *Cinquecento* architecture into Britain; and in noticing it more particularly, and tracing its course, we are saved the trouble of keeping up a distinction between the different parts of our triple nation, because, at the time it actually crossed the channel, the amalgamation of the kingdoms had taken place by the union of their crowns on the head of the Scotish sovereign.

English architecture.

When the Pointed style received its deathblow in England, in the reign of Henry VIII., it did not immediately cease to exist; nor was it immediately succeeded by the Italian when it became extinct. It was gradually declining through all the 16th century, during the latter part of which period, what has been called the Elizabethan style became somewhat permanent. It consists of a singular admixture of the Italian orders, with many peculiarities of the Pointed style, and in many examples the latter appears predominant. With such difficulty, indeed, did that fascinating manner give up its hold on the minds of men in this country, that the *cinquecentists* appear to have relinquished the hope of effecting its destruction,—unfortunately, however, not until the injury was done; and for some time we were left without a style of any kind, unless that may be called by the name which marks the edifices of the reign of James I., and of which the oldest parts of St James's palace are a specimen.

The destruction of the Pointed style has been referred by some to the change in religion which took place under the Tudor line of English monarchs; but such was certainly not the case. It was the "Reformation" of architecture in Italy, and not that of religion in Great Britain, that effected it; and it may be doubted whether the change would not have taken place sooner in this country, if its connection with Italy had not been so materially affected by the moral change here, and so delayed that of architecture; for it was Germany and France that supplied us with architectural reformers during the reigns of Henry VIII. and his children, and not Italy, whose professors might possibly have obtained more credit than their disciples did.

So dilatory were we, indeed, in the cultivation of the Italian style, that the first professor of it who was actually employed on edifices in this country came hither from Denmark! It is true, he was an Englishman; but so little hope did he appear to have of success at home, that he accepted an invitation from the king of that country, when he was at Venice, whither he had gone to study painting; but becoming enamoured of architecture, as he saw it in the works of Palladio, he had made that his study instead, and had already acquired considerable reputation in that city, when Christian IV. of Denmark invited him to his court to occupy the post of his first architect. A train of circumstances, to which we need not here advert, brought him to England a few years after James I. came to the English crown, and he was appointed architect at first to the queen, and subsequently to Henry prince of Wales. But he does not appear in consequence to have then obtained employment; for after the death of the prince, he went again to Italy, where he remained till the office of surveyor general, which had been promised him in reversion, fell vacant. This was the celebrated Inigo Jones, who has been called the English Palladio; and indeed he succeeded so well in acquiring the peculiar manner of that architect, that he richly deserves whatever credit the appellation conveys. It is unfortunate, however, for his own reputation, that he had not looked beyond Palladio and their common preceptor Vitruvius, to the models the latter pretends to describe; in which case he might have been the means of restoring, or at least of introducing, to his own country, the truly classical architecture of the ancients. But instead of that he brought nothing home but Italian rules and Italian prejudices. Jones commenced the truly Gothic custom of thrusting *Cinquecento* fittings into our Pointed cathedrals, by putting up an Italian screen in that of Winchester; and he barbarized the ancient cathedral of St Paul in London, by repairing it according to his notions of Pointed architecture, for it was in that style, and affixed to it an Italian front. Fortunately the great fire supervened, and made room for the present magnificent structure, by clearing away that early specimen of pseudo-classic taste. Of the Palladian style, however, it must be confessed Jones was a complete master. He designed a royal palace which was to have been built at Whitehall, in a manner as far superior to those of Versailles and the Escurial, as the works of Palladio are to those of Borromini. The only part of Jones's design ever executed is the structure called the Banqueting-House, whose exterior is an epitome of many of the faults, and most of the beauties, of the Palladian school. It rises boldly from the ground with a broad, simple, and nearly continuous basement or stereobate, and the various compartments of its principal front are beautifully proportioned; but the circular pediments to the windows, the attached unfluted columns, with broken entablatures and stylobates, the attic and balustrade, though they be the materials of Palladian, it may be confidently denied that they are consistent with classical architecture. Another well-known work of this architect is the Italo-Vitruvian Tuscan church of St Paul, Covent-Garden, whose eastern portico is well-proportioned in general, but grossly deformed in detail.

Architecture was in abeyance in this country, again, from the troublous times of Charles I. till the restoration of the monarchy in the person of his son, whose French taste would have completely Gallicized the architecture, as well as the manners and morals, of the nation, if the resplendent genius of Sir Christopher Wren had not been present to avert the infliction, or rather to modify it; for it cannot be denied that the influence of the French manner had an effect on the architecture of this country from that period down to the middle of the last century. Indeed Wren himself only knew the style he practised from books and the structures of France, except the few that existed of Inigo Jones in this country; and, in consequence of his visit to France, the peculiarities of the French style are obvious in many of his less esteemed works. Fortunately, however, he was proof against the grosser peculiarities of the *Cinquecento*, whether in the books of the Italians or in the edifices of the French; and his own productions evince that he had imbibed much of the spirit of the antique monuments of Italy, which he could have known only from engravings, and those very imperfect ones. The field that was opened to his genius by the great fire of London in 1666, and its result, are equally well known. It is true that the general offuscation of taste and feeling with regard to the Pointed style extended even to him. Wren was guilty of many offences in that respect, besides giving authority to the opprobrious term Gothic; and in no case more so than in the construction of the towers to Westminster Abbey, which are a lasting proof of his ignorance of its most obvious principles. Nevertheless, to the influence of our beautiful native style on his mind, architecture is indebted for some of its most charming works. If Wren had not been accustomed to contemplate the graceful and elegant pyramids or spires of his native country, he would never

History. have originated the tapering steeple, in the composition of which with the materials of Italian architecture he still stands as unrivalled as he was original. Witness the steeples of Bow Church and St Bride's in London, the former of which is hardly surpassed in grace and elegance by the Pointed spires themselves. It must remain a constant subject of regret that this great head of the English school of *Cinquecento* architecture did not know the remains of ancient Greece and Rome from personal observation. With his splendid genius and fine taste, if he had not been imposed on by the specious pretence of the Italo-Vitruvian school, his works would have been models for imitation and study, as they are objects of admiration: as it was, he avoided many of the faults of that school, and improved on many of its beauties. Without knowing the Greek style at all, and knowing the Roman only through imperfect mediums; without, indeed, ever having seen an example of either; whenever he has varied from the Italian practice, it has been towards the proportions and peculiarities of the Greek! The great west front of St Paul's, though it is said to be imitated from that of St Peter's in Rome, or rather from what it was proposed to be, with the two towers to form its wings, is a much finer, a more imposing, and more classical specimen of architecture than its prototype; for the advantage the latter should have in being of columns in one height is lost entirely in their poverty and in the miserable arrangement of the whole front; whereas that of St Paul's is in two noble pseudo-prostyle and recessed porticoes, with the columns fluted, and generally conceived and executed in much better taste than those of St Peter's. The entablatures, though massive, are finely proportioned, and sufficiently ornate to be elegant; they are, too, quite continuous, and the upper one is surmounted by a noble pediment, whose pyramidal form gives at the same time dignity and a finished appearance to the whole front. The coupling of the columns, however, and the putting of one columnar ordinance over another, can only be defended by the practice of the Italian school; though, in the present case, both are rendered less offensive by the judicious management of the architect. Nothing shows more strikingly the superiority of St Paul's to St Peter's, as an architectural composition, than a parallel of their flanks. The great magnitude of the latter may strike the vulgar eye with admiration in the contrast; but the rudest taste must appreciate the surpassing merit of the former in the form and arrangement of the cupola, and the noble peristyle with its unbroken entablature and stylobate, out of which it rises, when compared with the sharper form and depressed substructure of that of St Peter's. The superiority of St Paul's in the composition of the main body of the edifice is not less in degree, though perhaps less obvious, than in the superstructure. In the one it is broken and frittered, and in the other almost perfectly continuous, in broad, bold, and effective masses.

Plate LXIV.

The history of the works of Sir Christopher Wren is the history of the architecture of the period in this country; and as it must be admitted that he was not so successful in the composition of the architecture of secular structures as of ecclesiastical, it will follow that our secular edifices of that time are of inferior merit. If it were not indeed an historical fact, it would hardly be credited, that Chelsea College, the old College of Physicians in London, and the halls of some of the city companies, are by the architect of Bow Church and St Paul's.

The style introduced by Sir John Vanbrugh, who may be said to have succeeded Sir Christopher Wren in the direction of architecture in England, was distinguished by massiveness unsuited to the style in which he built, which was of course Italian. It was, however, free from the vagaries and extravagancies which characterize that style generally in other countries at the same period, but was certainly more suited to the soberer character of ecclesiastical than of secular structures, whereas his principal works were noblemen's mansions. Vanbrugh's faults were generally those of Michel Angelo: he was a painter's architect, and did not understand beauty of proportion and detail so well as the pictorial arrangement of lights and shadows; to produce which in the *Cinquecento* it is almost necessary to part with all the higher beauties of architecture. Hawksmoor added to the style of his master that noble ornament in which Italian works are so very deficient —a prostyle portico. His compositions are marked by severe simplicity, and only want to be absolved from a few faults and enriched with a few elegancies to be among the best of modern times. Not the least distinguished architect of the same age (the first half of the 18th century) was the Earl of Burlington, who was a passionate admirer of the style of Palladio and Inigo Jones. Many of the edifices erected by Kent are believed to be from the designs of that amiable nobleman, who, with considerable talent, was, however, a somewhat bigoted devotee to Vitruvius and the *Cinquecento* generally, as well as to Palladio in particular; for he has frequently used columns representing half-barked trees, in conformity with the silly tales of Vitruvius, and the sillier whims of his disciples The portal of his own house in Piccadilly, and that of the King's Mews, are special examples of this bad taste, and of other faults of the school besides. Lord Burlington built for himself at Chiswick a villa on the model of the Villa Capra, or Rotonda, near Vicenza—a structure which has been called the masterpiece of Palladio. In form and proportion it is certainly elegant, but its details strongly exhibit the poverty of Italian columnar architecture, when unaided by the frittering which is its bane, and almost its sole dependence for effect. Gibbs was a contemporary of the same period. He too, like Hawksmoor, had imbibed a taste for the classic prostyle portico, which he evinced in St Martin's church in London; but that he also was in the trammels of the Italian school is no less evident, in the same structure, to a considerable extent, and still more so in the church of St Mary in the Strand, which is a bad specimen of architecture, and a favourable one of its style. During the following half-century (the latter half of the 18th) Sir William Chambers and Sir Robert Taylor were the most distinguished architects of this country. They were both men of talent and genius, who had availed themselves of the remains of Roman antiquity to good purpose; for as yet those of Greece were either unknown or unappreciated; and the former of them has left us, in the Strand front of Somerset House in London, perhaps the best specimen of its style in existence. Other parts of the same edifice, however, are far from deserving the same degree of praise: indeed, as an architectural composition, the river front is altogether inferior in merit to the other, though of much greater pretence. The inner fronts to the great quadrangle, though exhibiting good parts, are, as a whole, not above mediocrity. An air of littleness pervades them; and the general effect of the fronts themselves is made still worse by the little clock towers and cupolas by which they are surmounted; and to this may be added the infinity of ill-arranged chimneys, which impart an air of meanness and confusion that nothing can excuse. While Sir William Chambers and a few others were applying the best qualities of Italian architecture, indeed improving its general character, and, it may be said, making an English style of it, there were many structures raised in various parts of the country in a manner hardly superior to that of the time of James I; structures in which all the meanness and poverty of the

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Cinquecento are put forth, without any of its elegance of proportion, or that degree of effectiveness which men of talent contrived to give it. During the same period, too, the seeds of a revolution were sown, which has almost succeeded in ejecting the Italian style and its derivative from this country, without perhaps having as yet furnished a complete equivalent.

In the year 1748 James Stuart and Nicholas Revett, two painters pursuing their studies in Rome, having moreover paid some attention to architecture, issued " Proposals for publishing an accurate description of the Antiquities of Athens, &c." These proposals met with general approbation, and in consequence they determined on prosecuting their plan; but various hinderances prevented their arrival in Athens till March 1751, when they commenced measuring and delineating the architectural monuments of that city and its environs. In this work Messrs Stuart and Revett were unremittingly employed (as far as their own exertions went, for they were frequently interrupted by the Turks) for several years, so that they did not reach England with the result of their labours until 1755; and, by a series of almost unaccountable delays, the first volume of their work did not appear until the year 1762. Sixteen years more expired before the second issued from the press; and the third was not published until 1794, being nearly fifty years from the time the work was first announced! Avarice and envy had induced a Frenchman of the name of Le Roy, who was at Rome when our countrymen issued their proposals, to forestall them with the public, and rob them of the profit and reputation they were so hardly labouring to earn. This man went to Athens, and in a very short time collected some loose materials, with which he published at Paris, in 1758, a work which he called *Les Ruines des plus beaux Monumens de la Grèce, &c.*, in which he makes not the slightest mention of Stuart and Revett, nor of their labours or intentions, with all of which he was well acquainted. This work is moreover notoriously and grossly incorrect; so incorrect indeed, as to make it difficult of belief that its author ever saw the objects of which he professes to give the representations. Such as it is, however, it was from M. le Roy's work that the public had to judge of the merits and beauties of Greek architecture; for we have said that the first volume of Stuart and Revett's did not appear for several years after it, and that does not contain any pure specimen of the national or Doric style: the second, which does, was not published for twenty years after Le Roy's. Considering, therefore, the source from which the public had to derive information on the subject, it can hardly be wondered at that Greek architecture was vituperated on all sides; and by none with greater acrimony than by Sir William Chambers, whose apology must be, ignorance and the prejudices of education. He really did not know the style he carped at; and his education in the Italo-Vitruvian school had unfitted him for appreciating its grand, chaste, and simple beauties, even if he had known it. Notwithstanding the misrepresentations of Le Roy, the vituperations of Chambers, the established reputation of Italian architecture, and the trammels which Vitruvius and his disciples had fixed on the public mind, when Stuart and Revett's work actually appeared, the Greek style gradually advanced in esteem, by dint of superior merit alone—for it has had no factitious aids; and since that period Greece and all her colonies which possess remains of her unrivalled architecture have been explored, and we now possess correct delineations of almost every Greek structure which has survived, though in ruins, the wreck of time and the desolation of barbarism. To our country and nation, then, is due the honour of opening the temple of Greek architectural art,—of drawing away the veil of ignorance which obscured the beauties it contains,—and of snatching from perdition, and consequent oblivion, the noble relics of ancient architecture which bear the impress of the Grecian mind. Not only indeed were we the first to open the mine, but by us it has been principally worked; for among the numerous publications which now exist on the Hellenic remains, by far the greatest number, and indisputably the most correct, are by our countrymen, and were brought out in this country. It required, however, a generation for the effects of ignorance and prejudice in some, and imperfect knowledge in others, to wear away, before the beneficial effects of the Greek style could be obvious in our structures. The works of the Adams, who were contemporaries of and immediate successors to Sir William Chambers, evince a taste for the beauties of Greek architecture, but a very imperfect knowledge indeed of the means of reproducing them. The architects who have had the direction of our principal works during the first quarter of this century had the disadvantage of being pupils of those who were themselves, as we have shown, incompetent to appreciate the Greek style; and at a time too when the state of Europe shut up all access to the remains of Greece and Rome; so that no great improvement could perhaps be expected from them. When they shall have passed away, it is to be hoped that we shall find a new class, some of whom, indeed, are already before the world, who, having received their education since peace has opened the Continent, are prepared by the actual contemplation and study of the works of Egypt, Greece, Rome, and Italy, in all their varieties, to form new and pleasing combinations of their beauties, adapted to our wants,—to produce what may equal, if not surpass them all. The structures of Egypt may show how to arrange large masses harmoniously and effectively; those of Greece and Rome how to impart grace and dignity; and the structures of Italy how the materials of ancient architecture may be moulded to modern uses, while at the same time they give practical warning of what may result from the abuse of the most obvious principles of the art.

The difference between the representations of the Athenian antiquities by Stuart and his colleague, and the misrepresentations of them by Le Roy, appears to have opened the eyes of the world to those of ancient Rome, to see if they too had not been dealt with unjustly; for of late years much more correct delineations of them have appeared than those of Palladio and Desgodetz,—delineations of them as they exist, exhibiting the spirit of the originals, and not warped to the Vitruvian precepts, and thereby stripped of their best quality, truth. The excavation of the ancient cities of Herculaneum and Pompeii has opened to us much interesting matter, and some that is instructive: their ruins too have the advantage of being correctly delineated; so that we are at this time in possession of more knowledge of the architecture of the ancients, acquired in a few years by the actual examination of its relics, than our predecessors of the last generation were, after talking, and writing, and reading Vitruvius about it, for nearly four centuries.

It is an argument in proof of the classical beauty of the Pointed style, that when the eyes of men were opened to the perfections of Greek architecture, they began to discover its merits also. Pointed architecture, under the opprobrious name Gothic, had long been a subject of discussion among antiquaries; that is, essays were written by them to prove how the Pointed arch originated, but none appreciated its beauties. Our Pointed cathedrals and churches were, after the example of Inigo Jones, ruth-

History. lessly barbarized in repairing and fitting up. If an architect were employed to do any thing in or to one of them, he appears to have thought it incumbent on him to convert it to the doctrines of his own faith—to Italicize it. Deans and Chapters for the most part intrusted their commissions to country masons and plasterers, who also operated according to the laws of the "five orders." About the middle of the 18th century one Batty Langley endeavoured to draw the attention of the world to Pointed architecture, by reducing it to rules, and dividing it into orders. Fortunately he was only laughed at, and both he and the book he published on the subject were soon forgotten. One of the first men in rank and influence of his time, in matters of taste particularly, Horace Walpole, *patronized* Pointed architecture, but ineffectually. He had himself neither taste nor feeling to appreciate its beauties, as his Strawberry Hill clearly evinces; so that his patronage of it must have been the effect of mere whim, or a wish to lead a fashion. Delineations were indeed put forth from time to time, but generally so rude and imperfect, that, like M. le Roy to Greek architecture, they did more harm than good. The Society of Antiquaries, however, at length took up the subject, engaged Mr John Carter, an ardent and judicious admirer of our national architecture, and commenced the publication of a series of splendid volumes, containing engravings of its best specimens, from drawings and admeasurements by him. The "Antiquities of Athens" had already done much to dispossess men of their prejudices, by showing that Greek architecture, though neither Vitruvian nor Palladian, was nevertheless beautiful; and the great work of the Society of Antiquaries did the same for Pointed architecture. Since the death of Mr Carter, our native style has been beautifully illustrated, in a series of valuable works by Mr Britton, and elucidated in detailed "specimens," by Mr Pugin, a French gentleman but an English artist, and by a great variety of other useful and excellent publications; so that, at the present time, the Pointed style, too, is studied and understood, and not a few of our architects are now competent, not only to be intrusted with the repairs and restorations of the ancient structures, but also to originate new ones, which may rival all but their prototypes in beauty.

We have now, in this part of the subject, only to add a few remarks on the improvement which has taken place in domestic architecture, since men have begun to consider their own comfort and happiness of as much importance to them as the splendour of their religious edifices. The exhumated city of Pompeii has very clearly proved, that notwithstanding the extent and general beauty of the public buildings of the Romans, the houses of the commonalty were exceedingly plain and confined, while those of the higher classes, though internally elegant, were externally unpretending. The rooms were small and badly arranged, imperfectly secluded from the public gaze, and quite exposed to the inmates; pervious alike to the summer's heat and winter's cold. Indeed, the house of a Roman gentleman presents a very convenient model for a prison, but without many of the comforts which in modern times are thought necessary even in such places. Of this, however, we shall treat more in detail when we come to consider Roman architecture as a style. It has been stated as probable, that the use of wooden floors, and the consequent power of making additional stories without enormously thick walls, arose during the middle ages. That improvement, together with the use of glass for windows, gives an air of comfort and convenience to the earliest domestic structures of modern times, of which the ancients could have had no idea; but the latter were deficient in elegance, though indeed the use of windows tended to the introduction of external architectural decoration. With learning and civilization came refinement and luxury, and men began, though at a great distance, to imitate in their houses what they found of beautiful and splendid in the churches and monasteries. The exclusion, by glass windows, of currents of cold air, which carried the smoke off to the funnel in the roof of a hall or large room, when the fire was exposed in the middle of it, led to the invention and use of chimneys, which should convey it away without occupying the room at all. This is more particularly applicable to the colder countries north of the Alps, and it is in them that domestic building is best understood, and is best applied to produce comfort and convenience. Not that the *Palazzi* of Italy are not generally more pretending in their external architecture than the town mansions of this country; but they are deficient in those internal arrangements which tend to produce the greatest possible advantages—which, indeed, promote the enjoyments of domestic life.

In consequence of the refinements which now pervade the manners, habits, and customs of civilized life, and civilization having extended itself from the noble and the learned through almost the whole social system, men are no longer contented to admire the beauty and magnificence of public edifices, whether ecclesiastical or civil, and to witness the splendour and elegance of the palaces and mansions of the wealthy; but all are anxious to see in their own habitations that degree of decoration and beauty which they find so productive of pleasure and pleasurable emotions. Thus architecture is no longer confined to the temples of the Divinity and the palaces of the great, but its beauties are sought everywhere. In every edifice whose inhabitant has been fitted by education and habit to appreciate and enjoy the charm which arises from symmetry of form, beauty of proportion, and elegance of detail, the aid of architectural art is required.

Of Egyptian Structures.

The architecture of ancient Egypt is characterized by the boldness and magnitude of its parts, and the almost monotonous uniformity which pervades its features. The existing monuments of Egyptian architecture consist for the most part of temples and pyramids. Obelisks are generally found in connection with the former, so that perhaps they can only be considered as belonging to them, and not as distinct architectural works, or the sphinxes and other things of a similar nature must be considered as such also. Neither can the hypogea or excavations be correctly described as belonging to architecture, though they bear many of its features, and were perhaps the antitypes of regular architectural combinations.

The pyramids are almost solid masses of masonry, whose bases are squares, and whose inclined sides are nearly equilateral triangles: some of them are truncated, and some run up to a point. They are generally much injured on the surface by long exposure, so that it is impossible to say whether any of them were considered finished while in steps or receding courses, or if the angles were either filled up or worked off, to make smooth surfaces on the exterior. Some of them not only were made plain by working off, but remain so still; whilst others bear no indication of ever having been finished in that manner. In one existing example, that of the great southern pyramid of Dashour, the angles of the receding courses have been wrought off; and it is singular that the blocks of stone are not laid in horizontal courses, but at an angle inclined to the base; nor are its sides carried up to the top in one continued plane, but at about two thirds from the base they incline towards each other under a more obtuse angle.

It has been imagined, but not determined, that most of

Egyptian Structures. them have natural hills, either of earth or stone, for cores, or rather that hills have been cut to the shape, and built over with large courses of stone to give them the appearance of being solid masonry. If this be the case, the chambers and the passages to them, which have been discovered in some of the pyramids, have been carefully built around to have the appearance of being left in the construction, which is not very probable. Another suggestion, to account in some measure for the immense quantity of matter in them, is, that they are actually cut in living rock to a considerable height, and built above. This may be the case with regard to those which are of the stone the place affords; but some of them are of foreign material, externally at least, and of consequence cannot have been hewn in the native rock. More consistent with the genius of Egyptian undertakings, but hardly more probable is it, that the pyramids include or cover some such constructions as the labyrinth beyond Lake Mœris, spoken of by Herodotus, according to the suggestion we have made in another place, or chambers of some kind which may have been the depositories of the arcana of Egyptian learning and science. Such indeed is the immense extent of some of these extraordinary monuments of human industry and human folly, that no suggestion with regard to them can be considered wild, as they afford full scope for the imagination, without presenting any thing to support or refute any theory that may be applied to them.

The Egyptian temples, without possessing that entire uniformity of plan which those of the Greeks do, are very similar in arrangement and manner. The larger and more perfect structures do not externally present the appearance of being columned, a boundary wall or peribolus girding the whole, and preventing the view of any part of the interior, except perhaps the towering magnificence of some inner pylones; of the lofty tops of an extraordinary avenue of columns, with their superimposed terrace; of the tapering obelisks which occupy, at times, some of the courts; or of a dense mass of structure, which is the body of the temple itself, inclosing the thickly columned halls. The immense magnitude of these edifices may perhaps have made them independent, in their perfect state, of considerations which have weight in architectural composition at the present time, and on which indeed its harmony depends. The various portions of the same temple differ in size and proportion; and being intermingled, the cornices of the lower abut indefinitely against the walls of the higher parts, while the latter are not at all in accordance among themselves.

Plate LII. The structure we produce to exemplify Egyptian architecture, though not, according to M. Champollion, one of the Pharaonic monuments, is perfectly characteristic of the style and arrangement of Egyptian temples, and is a more regular specimen than any other possessing the national peculiarities. It is known as the temple of Apollinopolis Magna, or of Edfou, in Upper Egypt, on the banks of the Nile, between Thebes and the first cataracts.

The plan of the inclosure behind the propylæa is a long parallelogram, the moles or propylæa themselves forming another across one of its ends. The grand entrance to the great court of the temple is by a doorway between the moles, to which there may have been folding gates, as the notches for their hinges are still to be seen. Small chambers, right and left of the entrance, and in the core of the propylæa, were probably for the porters or guards of the temple: a staircase remains on each side, which leads to other chambers at different heights. To furnish these with light and air, loop-holes have been cut through the external walls, which disfigure the front of the structure. The court-yard, cloister, or vestibule, has on three of its sides a colonnade, against the wall of the peribolus, forming a covered gallery. This, and the gradual ascent by corded steps to the great portico or pronaos, will be better understood by reference to the plan and section. The pronaos, or covered portico, consists of three rows of six columns each, parallel and equidistant, except in the middle, where the intercolumniation is greater, because of the passage through. The front row of columns is closed by a sort of breast-work or dado, extending to nearly half their height, in which moreover they are half-imbedded; and in the central opening a peculiar doorway is formed, consisting of piers, with the lintel and cornice over them cut through, as exhibited in the elevation of the portico. From the pronaos another doorway leads to an atrium or inner vestibule, consisting of three rows of smaller columns, with four in each, distributed as those of the pronaos are. Beyond this vestibule there are sundry close rooms and cells, with passages and staircases, whose intention is not obvious. The insulated chamber within the sixth door was most probably the adytum or inmost sanctuary, which may be supposed, in an Egyptian temple, to have contained a presentment of the divinity: the rest is inexplicable.

Egyptian Structures. Figs. 3 & 4. Fig. 2.

In many cases the temples are without the peribolus and propylæa, the edifice consisting of no more than the pronaos and the parts beyond it; and in others, particularly in those of Thebes, this arrangement is doubled, and there are two pairs of the colossal moles, the second being placed where the pronaos is in this, and another open court or second vestibule intervening them and the portico. In these the central line across the courts is formed by a covered avenue of columns, of much larger size than ordinary; and the galleries around are of double rows of columns instead of one row with the walls, as in this case. The obelisks marked in the plan, and indicated in the section, before the propylæa, occupy the situation in which they are generally found, though they do not exist with this example. Colossal sedent figures are sometimes found before the piers of the gateway; and from them, as a base, a long avenue of sphinxes is frequently found ranged like an alley or avenue of trees from a mansion to the park-gate, straight or winding, as the case may require.

Fig. 3. The longitudinal section of the edifice shows the relative heights of the various parts, and the mode of constructing the soffits or ceilings, which are of the same material of which the walls and columnar ordinances are composed: this is in some cases granite, and in others freestone. Fig. 2. The elevation of the pronaos shows also a transverse section of the colonnades and peribolus. It displays most of the general features of Egyptian columnar architecture; the unbroken continuity of outline, the pyramidal tendency of the composition, and the boldness and breadth of every part. The good taste with which the interspaces of the columns are covered may be remarked. Panels standing between the columns would have had a very ill effect, both internally and externally; and if a continued screen had been made, the effect would be still worse, as the columns must then have appeared from the outside absurdly short; but as it is, their height is perfectly obvious, and their form is rendered clear by the contrast of light and shade occasioned by the projection of the panels, which would not exist if they had been detailed between the columns. Figs. 6 & 7. The lotus ornament at the foot of the panels is particularly simple and elegant; and nothing can be more graceful and effective than the cyma above their cornice, which is singularly enriched with ibis mummy-cases. The jambs forming a false doorway in the central interspace, are a blemish in the composition; and they injure it very much by the abruptness of their form, and their want of harmony with any thing else in it. It may be remarked, that the effect of the front generally is that

Egyptian Structures.

of an excavation rather than of a structure, the end piers and entablature having a unity of purpose, which leads to the idea that the rest was similar, or the whole at first a plain wall afterwards pierced and carved into its present form. This view of it would support the supposition that the excavations or hypogea are the antitypes of columnar architecture.

Fig. 1. The front elevation of the moles or propylæa, with the grand entrance between them, is peculiarly Egyptian; and very little variety is discoverable between the earliest and latest specimens of this species of structure. It is an object that must be seen to be appreciated; simplicity and an inherent impressiveness in the pyramidal tendency are all on which it has to depend for effect, except magnitude, which alone would certainly make no agreeable impression on the mind. The projecting fillet and coving which form a cornice to the structures, though large and bold, appear small and inefficient when compared with the bulk they crown; and there is nothing particularly striking in the torus which marks the lateral outline and separates the straight line of the front from the circular of the cornice. Neither are they dependent for their effect on the sculpture, for their appearance is as impressive at such a distance as to make the latter indistinct, as when they are seen near at hand. The effect of the sculptures and hieroglyphics generally on Egyptian architecture is to enrich the surfaces, but not to interfere with the general form of a structure, or even with the forms of its minor parts.

A portion of the portico is given on a larger scale, to show more clearly the forms and arrangement of Egyptian columnar composition. The shaft of the column in this example is perfectly cylindrical. It rests on a square step, or continued stylobate, without the intervention of a plinth or base of any kind; and has no regular vertical channelling or enrichment, such as fluting, but is marked horizontally with series of grooves, and inscribed with hieroglyphics. The capitals are of different sizes and forms in the same ordinance. In this example the capital, exclusive of its receding abacus, is about one diameter of the column in height. Its outline is that of the cyma, with a reversed ovalo fillet above, and its enrichment consists principally of lotus flowers. The capital of the column next to this, in the front line, is much taller, differently formed, and ornamented with palm leaves; the third is of the same size and outline as the first, but differently ornamented; and the corresponding columns on the other side of the centre have capitals corresponding with these, each to its fellow, in the arrangement. Above the capital there is a square block or receding abacus, which has the effect of a deepening of the entablature, instead of a covering of the columns when the capitals spread, as in this case. In the earlier Egyptian examples, however, in which the columns are swollen, and diminished in two unequal lengths, the result is different, and the form and size of the abacus appear perfectly consistent. The height of this column and its capital, without the abacus, is six diameters. The entablature consists of an architrave and cornice, there being no equivalent for the frieze of a Greek entablature, unless the coving be so considered, in which case the cornice becomes a mere shelf. The architrave, including the torus, is about three quarters of a diameter in height, which is half that of the whole entablature. The architrave itself is in this example sculptured in low relief, but otherwise plain. The torus, which returns and runs down the angles of the building, is gracefully banded, something like the manner in which the fasces are represented in Roman works. The coving is divided into compartments by vertical flutes, which have been thought to be the origin of triglyphs in a Doric frieze; but these are arranged without reference to the columns, and are in other respects so totally different from them as to give but little weight to the suggestion. The compartments are beautifully enriched with hieroglyphics, except in the centre, where a winged globe is sculptured, surmounting another on the architrave, as shown in the elevation of the pronaos. The crowning tablet or fillet is quite plain and unornamented. Angular roofs are unknown in ancient Egyptian buildings, and consequently pediments are unknown in its architecture.

Fig. 5. Fig. 2. Plate LI. Fig. 7. Plate LII. Fig. 5.

Of the style of architecture used in the domestic edifices of the Egyptians we can give no idea, as no documents remain by which it may be known; neither can we judge of it by analogy from what we know of that of other nations of antiquity, for no direct analogy exists between the styles of their still existing structures. Indeed the Romans are the only people, before the Christian era, of whose domestic architecture we know anything with certainty; and the advantage they possessed over their predecessors in their knowledge of the use of the arch was so great, for that purpose especially, that theirs affords no certain index to that of the Greeks even, and none whatever to that of the Egyptians.

Hindoo Structures.

Of Hindoo Structures.

From local circumstances, structures in India are exposed to rapid destruction as soon as they lose the protecting power of man; and thus the absence of any positive architectural works in that country which can be determined to be of high antiquity may be partly accounted for. But religious intolerance and devastating war have conspired together to aid natural causes in the destruction of the ancient edifices of the Hindoos. Whatever of antiquity fell in the route of that ruthless conqueror Mahmood of Ghizni, in his twelve expeditions into India, was defaced or destroyed; and those structures in the more remote parts, impervious to his march, either want data to pronounce on their antiquity, or, when they possess any, it is in a character still unintelligible to the learned. But there are some to which tradition—and this we should not altogether reject—assigns a date beyond the age of Alexander; and we understand that the unity of style of these warrants the assumption of immense priority for them to all now existing in Gangetic India. It is from Rajpootana that we may yet look for developments of the ancient architecture of the Hindoos; a field of great magnitude, only just begun to be explored, and still remaining undelineated. Extensive excavations, however, of much greater magnitude even than those of Egypt, and, it is presumed, of at least equal antiquity, are found in various parts of India; and they may be supposed to bear some resemblance to their contemporaneous structures, of which, most likely, they were either the representations or the originals. But we thus arrive only at the style: the composition and arrangement of structures cannot be deduced from the hypogea; for though these latter in Egypt agree in style with the architecture, they would not suggest the other particulars.

The most common Hindoo pagoda of the present day is composed of a rectangular mass, surmounted by a graduated truncated pyramid. That this species of structure is of very considerable antiquity, may be concluded from the fact, that every thing in its composition and arrangement is determined by immutable precepts of a religious nature. This was ascertained by Colonel Tod, the learned annalist of Central India, from a man to whom the precept had descended with his profession from his ancestors through more than forty generations.

These kinds of evidence, however, though interesting, are not conclusive; and we must consent, for the present at least, to remain in ignorance of the Hindoo archi-

tecture of the early ages, to which our inquiry is more immediately directed. The splendid works of the Moslem conquerors of that country bear no relation whatever to its indigenous architecture.

Of Grecian Structures.

As no nation has ever equalled the Egyptians in the extent and magnitude of their architectural monuments, neither have the Greeks been surpassed in the exquisite beauty of form and proportion which theirs possess. Extreme simplicity and perfect harmony pervade every part of a Greek structure; and to the evanescence of the finer spirit of these qualities may be referred the difficulty—for great difficulty certainly exists—of applying Grecian architecture to modern practice. The national style, or Doric Order, is in every respect the most distinguished and the most intractable. The voluted Ionic being more complicated, is more plastic; and the foliated Corinthian, from its still greater divergence from Doric simplicity and harmony, is the most easily moulded to various purposes. Unfortunately nothing remains from which we might acquire a knowledge of the practice of the Greeks themselves in the architecture of domestic and general structures; but it may be inferred from some existing edifices, particularly the Choragic monuments, that the Doric columnar style was not used by them except for the temples of the gods and some of their accessories. But whether this arose—if the feeling really did exist—from the sanctity of its character, in consequence of that appropriation, or from the difficulty of moulding it to general purposes, cannot be determined. It is very certain, however, that the few structures which do exist of Greek origin, not of a religious character, are either Ionic or Corinthian, or a mixture of one of them with some of the features of the Doric; and in all Greece and the Grecian colonies, except Ionia, there are very few examples of religious edifices not of the Doric order, and none which are of the Corinthian.

We have already given our reasons for mistrusting the descriptions of ancient writers on architectural subjects; and when they merely make reference to different parts of a structure, without pretending to describe, in the absence of examples or models they must be unintelligible, and therefore no more valuable to the architectural antiquary than those of the writers, whom existing specimens of what they profess to describe prove to have been totally ignorant of their subject. We shall therefore not attempt to develope what does not exist, either from inferences to be drawn from Homer and others, from the professional dicta of Vitruvius, or from the description of Pausanias; but confine ourselves to the remains of the structures themselves of the Greeks, which are actually before our eyes, for the elucidation and exemplification of the Grecian style.

Like the architecture of Egypt, that of Greece is known to us principally by means of its sacred monuments, and from them is deduced almost all we know of its principles. The Doric temples of the Greeks are uniform in plan, and differ only in arrangement and proportion, as they are of greater or less size; for every part depends on the same modulus. If the dimensions of a single column, and the proportion the entablature shall bear to it, were given to two individuals acquainted with the style, with directions to compose a hexastyle peripteral temple, or one of any other description, they would produce designs exactly similar in size, arrangement, features, and general proportions, differing only, if at all, in the relative proportions of minor parts, and slightly perhaps in the contour of some of the mouldings. This can only be the case with the Doric, and it arises from the intercolumniation being determined by the arrangement of the frieze with triglyphs and metopes; the frieze bearing a certain proportion in the entablature to the diameter of the column, and so on, in such a manner that the most perfect harmony is preserved between every part. Thus, in the example, the column is so many of its diameters in height; it diminishes gradually from the base upwards, with a slightly convexed tendency or swelling downwards; and is superimposed by a capital proportioned to it, and coming within its height. The entablature is so many diameters high also, and is divided, according to slightly varying proportions, into three parts—architrave, frieze, and cornice. A triglyph bearing a certain proportion to the diameter of the column is drawn immediately over its centre; the metope is then set off equal to the height of the frieze; another triglyph is drawn, which hangs over the void; then a metope as before; and a second triglyph, the centre of which is the central line for another column; and so on to the number required, which, in a front, will be four, six, eight, or ten columns, as the case may be, the temple being tetrastyle, hexastyle, octastyle, or decastyle; and on the flanks twice the number of those on the front and one more, counting the columns on the angles both ways. Thus a hexastyle temple will have thirteen columns on each flank, an octastyle seventeen, and so on. It must be observed, however, that to ease the columns at the angles, they are not placed so that the triglyph over them shall impend their centre as the others, but are set in towards the next columns so far that a line let fall from the outer edge of the triglyph will touch the circumferential line of the column at the base, or at its greatest diameter. It has been generally thought that the object in this disposition was to bring the triglyph to the extreme angle, to obviate the necessity of a half-metope there; and many imitators have puzzled themselves to no avail to effect it without contracting the intercolumniation or elongating the first metope; though it is perfectly obvious that the intention of the Greek architects was to ease the columns in those important situations of a part of their burden, and for no such purpose as Vitruvius and his disciples have thought. Indeed, this has been a problem to the whole school, which their master proposed, and which they have settled only by putting a half-metope beyond the outer triglyph; thus preserving the intercolumniation equal, but rendering the quoins more infirm, or perhaps less stable, than the Greek architects judiciously thought they should be. Besides contracting the intercolumniation, the Greeks also made the corner columns a little larger than the rest, thus counteracting in every way the danger that might accrue to them, or to the structure through them, from their exposed and partly unconnected situation. The graduated pyramidal stylobate on which the structure rests also bears a certain proportion to the standard which is the measure of all the rest; and so every part is determined by the capacity of the sustaining power. Though the Doric order thus possesses, as it were, a self-proportioning power, which will secure harmony in its composition under any circumstances, yet skill and taste in the architect are necessary to determine, in every instance, the number of diameters the column shall have in height, and according to that assign the height of the entablature. For these two points in proportioning, and for appropriate detail and enrichment, he may, without servility, refer to the ancient examples; with the confidence, moreover, that in availing himself of their beauties he acquires the power of producing an object that shall be itself beautiful, while he can avoid being a mere copyist in the adaptation and arrangement of the materials of his composition, as well as in the selection

Plate LIII. Figs. 1 & 4.

Plate LIV. Fig. 3. Plate LIII. Fig. 3. Fig. 1 & 4.

Grecian Structures.

of them. We cannot discover that the elevation of the pediment depended so immediately on the common standard, though in the best examples the tympanum will be found to be about one diameter and a half in height.

The Ionic and Corinthian, or Voluted and Foliated orders, do not possess that innate principle of harmony which pervades the Doric, and therefore they are, as styles, less perfect, and depend more on factitious combinations. The Greek compositions of Ionic and Corinthian are of such consummate beauty in every particular, that their examples appear perfect, and may therefore be taken as models for study, in preference to the rules which have been laid down for those orders, without a knowledge of these exemplifications. With a consciousness of their inferior capacity to produce grand and harmonious effects in such arrangements as their temples require, the Greeks never applied either the Ionic or the Corinthian peripterally, and, as far as we have certain knowledge, only the latter in prostyles. Whether the Ionians did or did not, cannot be satisfactorily ascertained, as their temples are in every case so much destroyed, that it is impossible, at least without more care and attention than they have yet received, to make out satisfactorily what their plans were. In the Ionic and Corinthian orders, the proportions of the various parts are generally made dependent on the diameter of the column, as in the Doric; but the intercolumniations, and consequently the general proportions, of a composition, are not determined by the column and its accessories according to their capacity, but must be left to the taste and skill of the architect, as well as the columnar proportions themselves. This gave rise to the rules referred to, which are laid down by Vitruvius, for what he calls the "Five Sorts of Edifices," or, more correctly, species of intercolumniation. They are pycnostyle, systyle, diastyle, aræostyle, and eustyle, to each of which a fixed space is assigned. Architects will, however, act more wisely in judging for themselves, by reference to the best models of antiquity, what proportion constitutes an *Eustyle* intercolumniation, according to the application of his ordinance, than by attending to such irrational dogmas as are contained in that classification.

The temples of the Greeks are described, according to their external arrangement, as being either in antis, prostyle, amphiprostyle, peripteral, pseudo-peripteral, dipteral, or pseudo-dipteral; and internally, as cleithral or hypæthral. The columnar arrangement in antis is not common in Greek architecture, though there are examples of it, generally of the Doric order. The inner porticoes or pronaoi of peripteral temples are for the most part placed in antis, as may be seen by reference to the examples, in which columns stand between the antæ. The Ionic temples of Athens are the principal examples of the simple prostyle. They may be called apteral, if it be necessary to distinguish them from peripteral, as the latter are prostylar; but the former term alone is sufficient. Neither does Greek architecture present more than one example, and that is at Athens also, of an amphiprostyle, except in the same peripteral structures, which are also amphiprostylar. Almost all the Doric temples are peripteral, and being peripteral, they are, as a matter of course, amphiprostylar, as we have just remarked; so that the former term alone is used in describing an edifice of that kind, with the numeral which expresses the number of columns in each of its prostyles. There is but one known example of Greek antiquity of a pseudo-peripteral temple, and that is the gigantic fane of Jupiter Olympius at Agrigentum in Sicily. It is not even prostylar, for the columns on its fronts are attached, as well as those on its flanks. The dipteral arrangement is found at Selinus, in an octastyle temple; and in some cases the porticoes of peripteral temples have a pseudo-dipteral projection, though no perfect example of the pseudo-dipteros exists.

Plate LIII. Fig. 2, and Plate LIV. Fig. 2.

Most of the temples of the Greeks were cleithral; those to the inferior and demi-gods were invariably so. The fanes of the supreme divinity were almost as invariably hypæthral, and frequently those of other superior gods were of the latter description also. The Doric order was never used by the Greeks in mere prostyles; consequently there is no Doric temple of the tetrastyle arrangement, for it is incompatible with the peripteral, the tetrastyle examples which do exist being all Ionic.[1] With very few exceptions, all the Doric temples of the Greeks are hexastyle. Their queen, however, the unmatched Parthenon, is octastyle; and the pseudo-peripteral fane of Jupiter Olympius at Agrigentum, just referred to, presents the singular arrangement, heptastyle. No example exists in Greek architecture of a portico of more than eight columns, except the mis-shapen monument called the Basilica at Pæstum, the Thersites of its style, be so considered, and that has a front of nine columns, or an enneastyle arrangement.

Plate L.

It may be here remarked, in support of the opinion we have given as to the authority of Vitruvius, that, according to him, peripteral temples have on each flank twice the number of intercolumniations they have in front; thus giving to a hexastyle eleven, to an octastyle fifteen columns, and so on, whereas in the Greek temples this is never the case, for they always have more. The best examples have two, some have only one, but many have three, and in one instance there are four intercolumniations more in flank than in front. Again, he limits the internal hypæthral arrangement to those structures which are externally decastyle and dipteral, though an example, he says, existed in Greece of an octastyle hypæthros, and that was a Roman structure. Now, the Parthenon is an octastyle hypæthros, but all the other hypæthral temples, both in Greece and her colonies, are hexastyles, except perhaps the octastyle dipteral at Selinus; and there is no evidence in existence that the Greeks ever constructed a decastyle dipteral temple.

A Greek temple, whose columnar arrangement is simply in antis, whether distyle or tetrastyle, consists of pronaos and naos or cella. A tetraprostyle may have behind it a pronaos and naos. An amphiprostyle has, in addition to the preceding, a posticum, but is not understood to have a second entrance. The porticoes of a peripteral temple are distinguished as the porticus and posticum, and the lateral ambulatories are incorrectly called peristyles. It may indeed be here suggested, that as the admixture of Latin with Greek terms in the description of a Grecian edifice cannot be approved of, it would perhaps be better to apply the term *stoa* to the colonnaded platform or ambitus altogether, and distinguish the various parts of it by the addition of English adjectives: or the common term portico would be quite as well with front, back, and side or lateral, prefixed, as the case may be. Within the back and front stoas or porticoes, then, a peripteral temple has similar arrangements in antis, which are relatively termed the pronaos and opisthodomus, with an entrance only from the former; unless there should exist, as there does in the Parthenon, a room or chamber within the opisthodomus, supposed to be the treasury, when a door opens into it from the latter. Besides these,

Plate LIV. Fig. 3.

Plate LIII Fig. 3.

[1] Athens itself containing a Doric tetraprostyle, may seem to contradict this; but it must be recollected that we have already said (page 442), that in speaking of Greek architecture, we exclude all the examples, even in Greece itself, which were executed under the Roman dominion, for they bear the Roman impress; and that is one of them.

Grecian Structures.

a Greek temple of the most ramified description consists only of a cell, in those which are cleithral; and of a naos, which is divided into nave and aisles, to use modern ecclesiastical terms, in an hypæthral temple.

The only pure Greek architectural works that remain to us, and of which we have certain information, besides temples, are, it has been already stated, propylæa, choragic monuments, and theatres. The Propylæum, or Propylæa, as applied to the Acropolis of Athens, is the entrance or gateway through the wall of the peribolus into it. It consists of a Doric hexaprostyle portico internally, with a very singular arrangement of its columns, the central intercolumniation being ditriglyph. This was done probably to allow a certain procession to pass, which would have been incommoded by a narrower space. Within the portico there is a deep recess, similar to the pronaos in a temple, but without columns in antis; a wall pierced with five doorways corresponding to the intercolumniations of the portico, close the entrance; and beyond it is a vestibule, divided into three parts by two rows of three Ionic columns, and forming an outer portico, fronted externally by a hexaprostyle exactly similar to that on the outside. Right and left of it, and setting out about one intercolumniation of the portico from its end columns, at right angles, are two small triastyle porticoes in antis, with chambers behind them. These have been called temples, but most probably they were nothing more than porters' lodges or guard-houses. The whole structure, though extremely elegant, and possessing many beauties, is not a good architectural composition: the unequal intercolumniation detracts from its simplicity and harmony. The use of Ionic columns in a Doric ordinance is equally objectionable; and their elevation from the floor of the portico on insulated pedestals is even worse, though their intention is obvious; and without raising them, the ceiling might have been too low, or they must have been made taller.[1] The uneven style of the small temples or lodges is not pleasing, even though they be taken as flank and not as front compositions; and, moreover, their entablature abuts indefinitely against the walls of the larger structure, both internally and externally, to the total destruction of the harmony of the general composition. Indeed the unequal heights of the entablature of the greater ordinance involves a fault, if there were not something to prevent them from being seen in the same view, which it requires more than all the beauties of detail and harmony of proportion to countervail.

Plate LVI. Fig. 1 & 2. The choragic monument of Lysicrates, vulgarly called the Lantern of Demosthenes, at Athens, is a small structure, consisting of an elegant rusticated quadrangular basement or podium, which is more than two fifths of the whole height, surmounted by a cyclostyle of six Corinthian columns, attached to, and projecting rather more than one half from, a wall which perfects the cylinder up to the top of their shafts, where it forms a stand for tripods the height of the capitals. A characteristic entablature rests on the columns, and receives a tholus or dome, which is richly ornamented, and terminates in a foliated and heliced acroterium. To this Stuart has added dolphins as supporters, and has placed on the summit a tripod, which was the prize in the choragic festival; thus completing perhaps the most beautiful composition in its style ever executed. In Vitruvian language the arrangement of this edifice would be called monopteral; but it is more correctly cyclostylar, or, perhaps, because of the wall or core, it may be termed a pseudo or attached cyclostyle. The basement of this monument is eminently bold and simple, admirably proportioned to the rest of the structure, and harmonizing perfectly with it. The columnar ordinance is the only perfect specimen of the style in existence of pure Greek origin, and it has never been surpassed, perhaps not equalled, in beauty elsewhere. The most exquisite harmony reigns throughout its composition: it is simple without being poor, and rich without being meretricious; and the same applies to the superimposed tripod and its supports. Fig. 3.

Totally different in style and arrangement, and far inferior in merit, is the choragic monument of Thrasyllus. It bears, however, the impress of the Grecian mind. This composition is merely a front to a cave, consisting of three pilasters proportioned and moulded like Doric antæ, and supporting an entablature similar in style, but too shallow to harmonize with them. Above the entablature there is an attic or parapet, divided into three compartments horizontally. The two external form tablets with a cornice or impost on them, and the central is composed of three receding courses, on the summit of which is seated a draped human figure, whether male or female, in its mutilated state is not determinable. The entablature, instead of triglyphs in the frieze, has laurel wreaths; and it would appear as if the absence of the triglyph had deranged the whole composition. The two outer pilasters are of good proportion, and the architrave is well proportioned to them; but the frieze and cornice are both too narrow, and the spaces between the pilasters, equivalent to intercolumniations, are too wide. The third pilaster, itself inharmonious, is absurdly narrow, being narrower than the others; and, standing immediately under the statue, evidently to support it, its meagreness is the more obvious and striking. In spite of all this, the general outline of the structure is simple and pleasing, the detail is elegant, and the execution spirited and effective. This little monument is, however, a proof that the Greeks were not so excellent in architectural compositions at all times, as in the self-composing Doric temples, and in the choragic monument of Lysicrates; and to this evidence may be added that of the triple temple in the Acropolis of Athens. It consists of an Ionic hexaprostyle in front, resting on a bold, continuous, and well-proportioned stylobate, and forming the entrance to a parallelogramic cella, but, from all that has yet been discovered, without a pronaos in antis. The back-front consists of four columns like those of the portico, attached in antis; and the flanks are broad and bold, crowned by the well-proportioned and chaste entablature, with the enriched congeries of mouldings and running ornament of the antæ under it. In the absence of a pronaos to give depth to the portico, the composition was defective, but otherwise simple and harmonious. It was, however, completely spoiled by the attachment of a tetraprostyle to one of its sides, Ionic certainly, like that in front, but not only in a different manner, but of a different size; beautiful in itself, but a blot on the main building, with which it harmonizes in no one particular, being altogether lower; for the apex of its pediment only reaches to the cornice of the former. This and the Caryatidean portico are omitted in the example. In a similar situation, against the other side is attached a similar arrangement of Caryatides, a tetraprostyle of female figures raised on a lofty basement, and yet not reaching to the entablature of the main building,—according in no one particular either with it or with the portico on the other side, and altogether forming the most heterogeneous Plate LV.

[1] An editorial note in the new edition of *The Antiquities of Athens* says that "they are incorrectly mounted on pedestals" in Stuart and Revett's *Restoration*. This structure cannot perhaps fairly be judged of, until its site and remains shall have been examined without the jealous supervision of a Turkish governor.

Grecian Structures.

and inharmonious combination imaginable. Yet the two Ionic porticoes are the most beautiful examples of their Order in existence, and perhaps, it might be added, that were ever executed,—arranged in the finest proportion, and with the most exquisite details and enrichments. The Caryatidean frontispiece, also, for more it cannot be called, is full of architectural beauties, though it is most injudiciously collocated.

The theatres of the Greeks, it has been already intimated, present but little to interest in the view we are taking of architecture. They were not structures, but excavations; and whatever decoration they may have received to make them objects of interest externally, is, in every known example, entirely gone; and attempts to restore them from their remains as now existing, aided by all the information to be derived from ancient writers, would be futile, in the absence of a knowledge of the Greek style of art obtained from some other source. And as no existing example of the Greek theatre furnishes matter for architectural illustration, we should gain no information in furtherance of our present subject by treating of it here.

The division of the columnar architecture of the Greeks and Romans into orders by the Italian architects of the fifteenth century, according to the laws of Vitruvius, and the universal reception of that mode of arranging it, almost impose upon us the necessity of adopting the same course, and laying down a standard or model for each. But instead of so doing, we think it better to give each school separately, and describe the general features of the orders as they occur in the works of each,—pointing out, moreover, the varieties that exist, and prevent the monotony consequent on restricted forms and proportions. We retain, too, the term " Order," and the names in general use, without consenting to the propriety of either the one or the other; for if it be judicious to divide Greek and Roman columnar architecture into orders, there can be no reason why Egyptian, Hindoo, Persian, or any other style, should not be classed in a similar manner. Moreover, there is nothing in any one " order" that, were it not for custom, would not be thought as fitting in any other as in that to which it may belong. The Greeks did not hesitate to put triglyphs in the frieze of an entablature whose columns were fillet-fluted and had foliated capitals, as some ruins at Pæstum attest. As to names, the Doric might, as we have said, be called Corinthian with more propriety; the Ionic, Samian; and the Corinthian, Athenian; referring to the oldest known examples of each. The term Style would be more correct than Order, as it would indicate the column as the feature referred to, without conveying the idea of fixed rules; and architectural works into which columns do not enter need not be constrained to admit the arrangement of some Order in the composition, proportion, and detail of its various parts. In naming, too, the Doric might be called the Greek sacred or triglyphed style; the Ionic, the Voluted style; and the Corinthian, the Foliated; thus admitting any varieties of combination which could be expressed as composites of the voluted and foliated, or of the foliated and triglyphed, as the case might be.

An Order, according to Mr Gwilt, is " an assemblage of parts, consisting of a base, shaft, capital, architrave, frieze, and cornice, whose several services requiring some distinction in strength, have been contrived or designed in five several species,...each of which has its ornaments as well as general fabric proportioned to its strength and character." Perrault says that an order may be defined " a rule for the proportion of columns, and for the form of certain parts which belong to them, according to the different proportions which they have." We would have it understood to be a species of columnar arrangement, differing in its forms and general proportions, and in some leading features, from any other. Greek columnar architecture may thus be divided into the three arrangements or orders, Doric, Ionic, and Corinthian, which form its classes or styles. In considering them, however, it is necessary to discharge the mind of all the absurdities of the Italo-Vitruvian school about the proportions of the human figure being applied to columns, whether virile, matronal, or virginal; about the trunks of trees and rafters' feet; whether Doric columns should not have bases because men have feet, or that Ionic columns should have them because women wore sandals; that the guttæ in a Doric entablature should be conical, and not pyramidal, because they are to look like drops of water; that sculls, furies, thunderbolts, and daggers may be used to enrich a Doric frieze, but that spears, and swords, and stars, and garters may not;—these, with the thousand other puerilities of the *Cinquecentists*, whether Italian, French, or English,—whether acquired from the writings of Palladio and Scamozzi, of Perrault and Leclerc, or of Wotton and Chambers,—must be forgotten, and the greater or less degree of beauty resulting from this or that mode of arrangement and detail alone attended to.

Grecian Doric.

Not to induce the idea that the quoted examples of the antique should be imitated to the line and letter, but rather in spirit, we shall speak of the proportions of their various parts generally; though it must at the same time be understood that much of the beauty of a columnar composition depends on its minutiæ: still it is not necessary that these minutiæ should be mere repetitions of an original; it is in the spirit of the antique models that excellence is to be sought, and not in crude rules for their reproduction.

Of the Grecian Doric.

This order may be divided into three parts, Stylobate, Column, and Entablature. The stylobate is from two thirds to a whole diameter of the column in height, in three equal courses, which recede gradually the one above from the one below it, and on the floor or upper step the column rests. That graduation, it may be remarked, does not appear to have been made by the ancients to facilitate the access to the floor of the stoa or portico, but on the principle of the spreading footings of a wall, to give both real and apparent firmness to the structure, both of which it does in an eminent degree.

The column varies in different examples from four to six diameters in height, of which the capital, including the necking, is rather less than half a diameter: in those cases in which a necking does not exist, the capital itself occupies nearly the same proportion. The shaft diminishes in a slightly curved line, called entasis, from its base or inferior diameter upwards to the hypotrachelium, leaving it at that place, or at the superior diameter, from two thirds to four fifths of the lower or inferior, which latter is the diameter always intended when the term is used as a measure of proportion. The capital consists of a necking, an echinus or ovalo, and an abacus; the necking is about one fifth of the height of the capital, and the other two members equally divide the remaining four fifths: when there is no necking, the ovalo occupies the greater proportion of the whole height. The abacus is a square tablet, whose sides are rather more than the inferior diameter of the column. The corbelling of the ovalo adapts it to both the diminished head of the shaft and the extended abacus, flowing into the one, and forming a bed for the other by means of a graceful cyma-reversa; but its lower part is encircled by three or four rings or annulets, which are variously formed in different examples,

Plate LI. Fig. 10. Plate LIII. Fig. 4 & 9. Plate LIV. Fig. 4.

Fig. 6 & 7.

Grecian Doric.

and which are the means of giving the echinus form to the great moulding, although it is, as we have said, part of a cyma-reversa. The shaft is divided generally into twenty flutes; but there are several examples with sixteen, and there is one with twenty-four. The flutes are sometimes segments of circles, sometimes semiellipses, and sometimes eccentric curves. They always meet in an arris or edge, and follow the entasis and diminution of the column up through the hypotrachelium to the annulets, under which they finish, sometimes with a straight and sometimes with a curved head. At the base they detail on the pavement or floor of the stylobate.

Plate LIII. Fig. 12. Plate LIV. Fig. 8 & 14.

The third part of the order, the entablature, ranges in various examples from one diameter and three quarters to rather more than two diameters in height, of which about four fifths is nearly equally divided between the architrave and frieze, and the cornice occupies the remaining one fifth: this is in some cases exactly the distribution of the entablature. The architrave is in one broad face, four fifths, and sometimes five sixths of its whole height; and the remaining fifth or sixth is given to a projecting continuous fillet called the tænia, which occupies one half the space, and a regula or small lintel attached to it, in lengths equal to the breadth of the triglyphs above in the frieze. From the regulæ six small cylindrical drops called guttæ depend. There are examples to the contrary, but it may be taken as a general rule, that the architrave is not in the same vertical line with the upper face of the shaft, or its circumferential line, at the superior diameter, but is projected nearly so much as to impend the line or face of the column at the base. The frieze, vertically, is plain about six sevenths of its whole height, and is bounded above by a fascia, slightly projecting from it, which occupies the remaining seventh. Horizontally, however, it is divided into triglyphs and metopes, which regulate the intercolumniations in the manner that has been already described; the former being nearly a semidiameter in width, and the latter the space interposed between two triglyphs, generally an exact square, its breadth being equal to the whole height of the frieze, including the fascia. This latter breaks round the triglyphs horizontally, and is a little increased in depth on them. Each glyph, of which there are two whole ones and two halves to every tablet, is one fifth of the width of the whole, and the interglyphs are each one seventh of the whole tablet or triglyph. The glyphs detail on the tænia of the architrave, but are variously finished above. In some examples they are nearly square-headed, with the angles rounded off; in others the heads are regular curves, from a flat segment to a semiellipsis. The semiglyphs are finished above in a manner peculiar to themselves, with a turn or drop; but hardly two examples correspond in that particular. The tablets in which the glyphs are cut are vertical to the face of the architrave, the metopes recede from them like sunk panels; these are often charged with sculptures, and indeed almost appear contrived to receive them. The third and crowning part of the entablature, the cornice, in what may be considered the best examples, projects from the face of the triglyphs and architrave about its own height. Vertically, it is divided into four equal parts, one of which is given to a square projecting fillet at the top, with a small congeries of mouldings, different, and differently proportioned to each other, in various examples. Two other parts are given to the corona, and the remaining fourth to a narrow sunk face below it, with the mutules and their guttæ. These latter form the soffit or planceer of the cornice, which is not horizontal or at right angles to the vertical face of the entablature generally, but is cut up inwards at an angle of about 80°. The width of the mutules themselves is regulated by that of the triglyphs over which they are placed, to which it is exactly equal. They are ornamented each with three rows of six small cylinders, similar to those which depend from the regulæ under the triglyphs and on the architrave. There is twice the number of mutules that there is of triglyphs, one of the former being placed over every metope also in the manner the examples indicate.

Grecian Doric.

This completes the Greek Doric Order according to the generally received sense of the term; but there are other parts necessary to it. In the front or on the ends of a temple, or over a portico, a pediment is placed. Its intention is obviously to inclose the ends of the roof, but it forms no less a part of the architectural composition. In reason, it should be raised as much as the roof required; but when the span is great that would be unsightly; and reference appears to have been made to the common standard of proportion, as the pediments of most Doric temples are found to be about one diameter and a half in height at the apex of the tympanum, which in a hexastyle arrangement makes an angle at the base of about 14°, and in an octastyle about $12\frac{1}{2}$°. The pediment is covered by the cornice, without its mutules, rising from the point of its crowning fillet, so that no part of it is repeated in profile. Another moulding, however, is superimposed: sometimes this is an ovalo with a fillet over it, and sometimes a cymatium. It varies much in its proportion to the cornice, but in the best examples it is about one half the depth of the latter without its mutules. Ornaments of various kinds, statues or foliage, are believed to have been placed on the apices and at the feet of pediments as acroteria. Of these, however, we have no actual remains; but indications of the plinths or blocks which may have received them exist, and such things appear represented in ancient coins and medallions. The tympana of pediments are well known as receptacles of ornamental sculpture. On the flank of a Doric temple, the cornice supported a row of ornamented tiles called antefixæ. These formed a rich and appropriate ornament, but they rather belonged to the roof than to the columnar arrangement or order. The antefixæ covered the ends of the joint-tiles as the pediments did those of the roofs; and corresponding ornaments called stelai rose out of the apices of the joint-tiles, forming a highly enriched ridge.

Plate LIV Fig. 1.

Plate LIII. Fig. 1.

A secondary Doric order arises in the disposition of a Grecian temple, from the columns of the pronaos and the inner part of the external entablature continued and repeated. Of this the frieze is generally without triglyphs, though there may be regulæ and guttæ on the architrave. The fascia of the frieze is either moulded or enriched on the face; and, instead of a cornice, the beams of the ceiling are laid at equal intervals to support sunk panels or coffers, in which there may be flowers or other enrichments.

Fig. 9.

Propriety in the composition and arrangement of antæ is as necessary to the perfection of the Doric order as to that of the columnar ordinance itself, especially if the latter be *in antis*. Slight projections are made on the end and side faces of a wall, so as to form a species of pilaster, whose front shall be nearly equal to the diameter of the columns to which it is attached, exactly equal indeed to the soffit of the entablature, whose faces have been described as impending the circumferential line of the column at a little above its base. This rests on the stylobate in the same manner as the columns do, with sometimes a small continuous moulding as a base; and its capital is a congeries of mouldings, about the depth of the abacus, with a plain fascia corresponding to the ovalo of the columnar capital. The entablature of the order to which it is attached rests on it, and, continuing along the flank of the building, is received by a similar combination at the other end. These, it may be remarked, were never diminished or fluted,

Fig. 2, 3, & 10; and Pl. LIV. Fig. 2, 3, & 9.

Grecian Ionic.

being projections from and upon the ends and faces of walls, they could not be diminished without involving an absurdity; and fluting on a straight surface must be productive of monotony, as the flutes can only project a series of equal and parallel shadows. Not so, however, with columns, on whose rotund surface fluting produces a beautiful variety of light and shade in all their gradations, which it could not possess without that enrichment; for on a plain column neither are the lights so bright nor the shadows so dark as in the former case, nor are they so finely diffused over the whole surface in the one as in the other.

In the only example which occurs in the ancient architectural remains of attached Doric columns,—that of the pseudo-peripteral temple of Jupiter Olympius at Agrigentum—the stylobate is peculiarly arranged. The upper gradus is grooved, and detailed round the columns and along the walls between them; and a congeries of vertically arranged mouldings and fillets rests on it, and receives the base of the column.

Such are the materials of which the Greeks composed their beautiful temples, the manner of whose composition has been already described. Of their effect, however, it is impossible to form a competent idea without seeing one. And whence, it may be asked, does their interest arise? Pl. L. From their simplicity and harmony;—simplicity, in the long unbroken lines which bound their forms, and the breadth and boldness of every part; such as the lines of the entablature and stylobate, the breadth of the corona, of the architrave, of the abaci, of the capitals, and of their ovalos also; in the defined form of the columns, and the breadth of the members of the stylobate;—harmony, in the evident fitness of every part to all the rest. The entablature, though massive, is fully upborne by the columns, whose spreading abaci receive it, and transmit the weight downwards by the shafts, which rest on a horizontal and spreading basement; the magnitude of every part, as we have before had occasion to remark, being determined by the capacity of the sustaining power. Besides graceful and elegant outline, and simple and harmonious forms, these structures exhibit a bewitching variety of light and shade, arising from the judicious contour and arrangement of mouldings, every one of which is rendered effective,—by the fluting of the columns and the peculiar form of the columnar capital, whose broad, square abacus projects a deep shadow on the bold ovalo, which mingles it with reflections, and produces on itself almost every variety. The play of light and shade, again, about the insulated columns, is strongly relieved and corrected by the deep shadows on the walls behind them; and in the fronts, where the inner columns appear, the effect is enchanting. For all the highest effects which architecture is capable of producing, a Greek peripteral temple of the Doric order is perhaps unrivalled.

Of the Grecian Ionic.

Not less Hellenic in its detail than the national Doric is the graceful and elegant style called the Ionic, whose proportions and peculiarities we take from the perfect examples of the Athenian Acropolis.

Pl. LV. This order may also be considered in three similar parts, Stylobate, Column, and Entablature. The stylobate is in three receding equal courses or steps, whose total height is from four fifths of to a whole diameter. The column, consisting of base, shaft, and capital, is rather more than nine diameters in height, of which the base is two fifths of a diameter; and the capital, including the hypotrachelium, is in one case three fourths, and in the other seven eighths of a diameter high. The base consists of a congeries of mouldings, extending gradually from a diameter and a third to a diameter and a half, and its height is in three nearly equal parts, two equal fillets separating them. The lowest, a torus, rests on the top of the stylobate or floor of the portico, a fillet divides that from a scotia, a second fillet intervenes the scotia and a second torus, and a third fillet bases the apophyge or escape of the shaft. The upper torus of the base is, in one example, fillet-fluted horizontally; and, in the other, the same member is enriched with the guilochos. The shaft diminishes with entasis from its lower or whole diameter, to above five sixths of it immediately under the hypotrachelium. It is fluted with twenty-four flutes and alternating fillets, which follow the diminution and entasis of the column. The flutes in plan are nearly semiellipses, and they finish at both ends with the same curve: a fillet is in thickness nearly one fourth the width of a flute. The difference in the height of the capital is in the length of the necking, which in one case is separated from the head of the shaft by a carved bead, and in the other by a plain fillet. Above the necking, a height of about one third of a diameter is occupied by a congeries of three spreading or corbelling mouldings, a bead, an ovalo, and a torus, which are all appropriately carved. On these rests the parallelogramic block, on whose faces are the volutes, and whose ends are concaved into what is technically termed a bolster, to connect them. This part is about one third of a diameter in height, and includes a rectilinear abacus, whose edges are moulded to an ovalo, and carved with the egg and tongue ornament. The volutes are three fifths of a diameter in depth, and extend in front to one diameter and a half; and they are nearly a semidiameter apart. The flowing lines which connect the volutes can only be understood by reference to the example. The Fig. 5. bolsters are fluted vertically, with alternate fillets, on Fig. 12. which are carved beads. An ornament composed of the honeysuckle with tendrils encircles the necking of the column. It must be remarked, that as the capitals are parallelcgramic, and present but two similar fronts, to preserve the appearance of volutes externally on all sides, the capitals of those columns which occupy the external angles of porticoes are differently arranged. The outer Fig. 16. volute is bent out at an angle of 45°, and volutes are put on the end or side-front of the capital also, the outer one being the other side of the angular volute of the front. To suit the angle internally, the two volutes of the inner face are placed at right angles to each other: this is, however, at best but an awkward expedient, and need not be employed when a portico projects only one intercolumniation.

The entablature, which is rather more than two diameters in height, is also divided into three parts—architrave, Fig. 5. frieze, and cornice—which may be proportioned by dividing the whole height into five parts, four of which, as in the Doric, may be again equally divided between the architrave and frieze. The cornice, however, in the examples referred to, does not occupy one fifth of the entablature; but if it had a fillet over the upper moulding, which it appears to want, that would be just its proportion. If the architrave be divided into nine parts, seven of them may be given to three equal fascias, which slightly project the one before the other; the first or lowest, which is vertical to the circumferential line of the inferior diameter, being covered by the second, and the second by the third. The remaining two ninths form a band of mouldings corbelling a broad fillet, which separates the architrave from the frieze: these mouldings are enriched. The frieze, which does not project quite so much as the lowest fascia of the architrave, is, in the Athenian examples, quite plain; but it may be enriched with foliage, or made the receptacle of sculpture in low relief. The cornice projects from the face of the frieze rather more than

Grecian Ionic.

as much as its whole height, and is composed of bed mouldings, a corona, and crown mouldings. The first are a carved bead and carved cyma-reversa, the former of which only occupies a portion of the height of the cornice, as the planceer is cut up inwards in the manner represented by dotted lines in the example, to a sufficient depth for it; the crown mouldings, which consist of a carved ovalo above a carved bead, are rather more than one fourth of the whole cornice; and the corona occupies the rest of its height, except that small portion given to the bead of the bed mould. A fillet above the crown mouldings, as already intimated, is certainly necessary to complete the order and receive the antefixæ, as described in the Doric, for the flank of a temple.

Fig. 1 & 2. The pediments in the examples of Ionic are rather flatter than in those of the Doric, the angle made by the covering cornice with the base being, in a hexastyle, less than 14°. A vertical fillet, with a small moulding, equal in depth to the two crown mouldings of the cornice, covers them in the pediment, in the place of the cyma-recta or ovalo used in the Doric order. The intercolumniation differs in these examples; in the one it is two diameters, and in the other three diameters and one-sixth.

A much greater variety is found in the composition of the Ionic than of the Doric order. Indeed the examples of the Athenian Acropolis alone have neckings; in all the others the shaft runs up to the corbelled mouldings, which bed the block of the volutes, and the flutes finish under them. Neither have they a torus in that congeries, but a bead and ovalo alone, which latter makes an inconvenient projection under the pendent lines that connect the volutes, and thus the capital is not more than half a diameter in height.

The Asiatic or the truly Ionian examples of this order are far inferior to those referred to. Their bases are differently, and certainly less elegantly composed. They are without hypotrachelia, as may have been inferred; they want the torus in the capital; and, in most cases, instead of flowing, pendent lines, they have straight lines connecting the volutes. Their entablatures are not so finely proportioned, nor so delicately executed. The coronas want breadth, and the bed moulds of the cornice are as much too heavy as those of Athens are perhaps too light. Indeed, upon the whole, they have more of the grossness of Roman architecture than of the delicacy and elegance of Grecian, though the Ionian examples are supposed to be the models of those of Athens.

Fig. 10. The width of the antæ of the Ionic order is determined, as in the Doric, by the soffit of the entablature; and it will, of course, be exactly the same as, or rather less than, the inferior diameter of the column. It is slightly raised, too, from the face of the wall at the ends of which it stands. The base of the antæ is, in one of the two examples of the Acropolis, a little deeper than that of the column, having a small projecting moulding between the lower torus and the floor; and the lower torus itself is reeded. In the other example there is no difference in the form and proportion of the antæ and columnar bases, but both the tori are fluted horizontally, with beaded fillets between the flutes. The antæ cap consists of a congeries of corbelling mouldings, nearly one third of a diameter in height. It is divided into three nearly equal parts, the lowest of which is composed of a bead and an ovalo; the second of another bead and a cyma-reversa, all carved; and the third of a plain flat cavetto, with a narrow fillet and small crowning cyma-reversa, forming an abacus. The necking is like that of the capital, and is enriched in the

Fig. 3. same manner. The cap or cornice thus formed breaks round the projection of the antæ, and is continued along the wall under the entablature the whole length of the building, or till it is impeded by some other construction, and the base is continued in like manner.

Grecian Corinthian.

Fig. 2. Attached columns have the voluted capital, but their base is that of the antæ; and it is detailed round them and along the wall to which they belong, as with the antæ. It must be remembered, however, that the attached columns in the triple temple are about one ninth less in diameter than those which are insulated, though they are similar in other respects, and have the same entablature.

The back of the triple temple, between the attached columns, presents the only example in Greek architecture of windows. These are rather more than twice their width in height, and are narrower at the top than at the bottom. They rest on a broad, bold sill, which is equal in depth to two sixths of the opening, and are surrounded externally by a congeries of mouldings, which, with a plain fascia, constitute an architrave. This architrave is one fourth the opening in width; it diminishes with the window, and in the same proportion, and is returned above in two knees, which are made vertical to its extreme point at the base.

Of the Grecian Corinthian.

Plate LVI. Fig. 1. The importance which the Greeks attached to a graduated stylobate, and the necessity of giving it a relevant proportion in a columnar ordinance, are evinced in the only example of this order which remains to us of Grecian origin. Unlike the Doric and Ionic in its application, which is in temples of rectangular form, whose whole height they occupy, this is attached to a small circular structure, resting on a lofty square basement; and yet, like those orders, it has a stylobate in receding courses, and in plan, too, corresponding with the arrangement of the Fig. 2. columns, and not with that of the substructure; in this too offering further proof that the stylobate was considered a part of the columnar ordinance. Thus the Corinthian Fig. 1 & 3. order also consists of stylobate, column, and entablature. The stylobate is rather more than a diameter in height, and is divided into three parts, but not equally, in consequence, it is probable, of the peculiar position of the ordinance. The two lower grades have vertical faces, are of equal depth, and occupy three-fourths of the whole height; whilst the third step occupies the remaining fourth and is moulded on the edge, in exquisite harmony with the more ornate style, of which it forms a part. Like the column of the Ionic order, that of the Corinthian consists of base, shaft, and capital: it is ten diameters in height. The base is rather more than one third of a diameter high, and is composed of a torus and fillet, which are nearly two fifths of its whole height; a scotia and another similar fillet, rather less than the former; and a second torus or reversed ovalo, one fifth the height of the base, on which rests a third fillet basing the apophyge of the shaft. The extent or diameter of the base, at the lower torus, is rather more than one diameter and a half. The shaft diminishes with entasis to five sixths of its diameter at the hypotrachelium, and, like that of the Ionic order, has twenty-four flutes and fillets. The flutes are semiellipses, so deep as nearly to approach semicircles: they finish in the apophyge at the foot of the shaft, in the same manner and form; and at the head they terminate in leaves, to which the fillets are stalks. The fillets are rather more than one fourth the width of the flutes. The hypotrachelium is a simple channel or groove immediately under the capital. The capital itself is a diameter and rather more than one third in height: its core is a perfect cylinder, in bulk rather less than the superior diameter of the shaft. This is banded by a row of water leaves, whose profile is a flat cavetto, one sixth of the whole height, and another of leaves of the acanthus, with flowered buttons attaching them to the cylin-

Grecian Corinthian. der. These latter have the contour of a cyma-recta, and are twice the height of the last, or one third of the whole capital. Rather more than another third is occupied by helices and tendrils, which latter support a honeysuckle against the middle of the abacus; and the abacus itself, resting on and covering the whole mass, is but little more than one seventh of the whole height. This member in plan can only be described as a square whose angles are cut off at 45°, and whose sides are deeply concaved. In profile it consists of a narrow fillet, an elliptical cavetto or reversed scotia, and another fillet surmounted by a small ovalo, or rather a moulding whose profile is the quadrant of an ellipsis.

The entablature of this order is two diameters and two sevenths in height. It also consists of architrave, frieze, and cornice, of which the first occupies one tenth more than a third, the second rather more than as much less than that proportion, and the cornice is so much more again above one third. The architrave is divided, like that of the Ionic order, into three equal fascias, which occupy all but one sixth of its whole height, and that is given to a corbelled band, consisting of a bead, cyma-reversa, and fillet, separating the two members of the entablature. The fascias of the architrave, it must be remarked, are not perpendicular, but incline inwards, so that their lower angles are all in the same vertical line, which impends the surface of the shaft about one third of its height from the base. The frieze is one plain band, slightly inclining inwards, like the fascias of the architrave, and slightly projected beyond them: in this example it is enriched with sculptures. The cornice consists of a deep congeries of bed mouldings, and a corona, with the accustomed small crown mouldings and fillet. Its extreme projection is nearly equal to its whole height: of this the bed-mouldings project about two fifths. As in the Ionic cornice, additional height is given to the bed-moulds, by undercutting the planceer. In this case, the undercutting extends to nearly one-fourth the height of the corona. One-sixth the height of the cornice is given to a flat bead and an ovalo, which are immediately above the frieze, and which base a broad dentilled member that occupies more than one-fourth of the whole cornice. This is surmounted by a listel or broad fillet, above which is a cymarecta, whose narrow fillet nearly reaches the horizontal plane of the planceer, and separates it from a cyma-reversa that beds the superimposed projecting corona. This latter is only three eighths of the whole cornice, and nearly one of the three is given to the ovalo and fillet, the bed-moulds alone occupying five eighths. The cornice is surmounted by a cut fascia supporting honeysuckle antefixæ, which may indeed be taken as a part of the order, as the solitary example in question presents it. This, however, we know, from the Doric and Ionic structures, to be a modification of the flank ornament of temples; and we may suppose from analogy, that if used in a portico, the cornice of this order would have a cyma-recta to crown it on the inclined side of the pediment. The intercolumniation of this example is two diameters and one third.

Of Corinthian antæ we have no examples, nor indeed have we of insulated columns; but as we find in the Ionic examples quoted, that the attached columns are less in proportion to the entablature than those which are insulated, we may conclude that it would be the same with this; thus reducing the entablature to two diameters, the ordinary average of that part in Greek columnar architecture.

Of the Caryatides, or Caryatic Order.

Fig. 4, 5, & 6. The solecism in architecture of which we have now to speak has but the one existing example in the works of the Greeks, to which we have already referred. It is the third portion of the triple temple in the Athenian Acropolis, and is a projection from the flank of the principal Ionic structure, formed by a stereobatic dado raised on the stylobate and antæ-base mouldings of it, with a surbase consisting of a carved bead and carved ovalo covered by a broad listel, with a narrow projecting fillet above it. Caryatic Order. On this rests a square plinth, which bases a draped female figure, on the head of which there is imposed a circular moulded block, with a deep rectangular abacus, two thirds of whose face is vertical, and the other third is a cavetto, fillet, and small cyma-reversa. The stereobate, including the moulded base of the temple, is about three fourths the height of the statue-pillar with its base and capital. The entablature is rather less than two fifths of the same, but it consists of architrave and cornice alone, between which parts the height is nearly equally divided. Rather more than one fifth of the former is given to a carved bead and carved cyma-reversa, with the flat, plain cavetto and fillet which they support; the other four-fifths is divided nearly equally into three fascias, of which the third or upper one has a fraction more than the other two, and is studded with plain circular tablets, whose diameter is five sixths of its depth. The cornice consists of bed-mouldings, corona, and crown mouldings. Two fifths of its whole height is given to the bed-mould, to which one seventh of that may be added for the portion cut up in the planceer. Half that increased height is occupied by a dentilled member, and the other half by a broad plain fillet, a carved bead, carved cyma-reversa, and a narrow fillet above it. The remaining three fifths of the whole cornice being again divided into five parts, rather less than two of them is given to the corona; a little more than one to a plain cyma-reversa and fillet, of which the latter is the wider; and of the rest a carved ovalo occupies five sevenths, and a listel or crowning fillet, with a carved bead on it, the other two. A pier, pilaster, or antæ, projects from the wall of the greater temple, and receives the end of the entablature behind the inner figure; for the projection is of two statues and their interspaces. It does not, however, rest on the stereobate, but runs down to the base-mouldings of the temple, the dado and surbase abutting against it. The antæ is capped by a congeries of carved mouldings, which support a narrow cavetto and fillet: the height of the cap is half the diameter of the antæ. There is also a hypotrachelium, consisting of a carved bead and the honeysuckle ornament, occupying about one third of a diameter in height. This Caryatidean portico displays very clearly the arrangement of the ceiling, with its coffers or cassoons. Internally the architrave is plain two thirds of its height; of the remaining third rather more than one half is a plain, slightly projected, fascia; the other half is occupied by a carved bead and ovalo. In the absence of a frieze, the ceiling rests on this, and is divided by carved beads into panels, which are deeply coffered, and diminished by three horizontal moulded fascias.

Of Grecian Mouldings and Ornament.

Pl. LVII. Greek architecture is distinguished for nothing more than for the grace and beauty of its mouldings; and it may be remarked of them generally, that they are eccentric, and not regular curves. They must be drawn, for they cannot be described or struck; so that though they be called circular, or elliptical, it is seldom that they are really so: not but that they may be, but, if they are, it is evidently the result of chance, and not of design. Hence all attempts to give rules for striking mouldings are worse than useless, for they are injurious: the hand alone, directed by good taste, can adapt them to their purpose, and give them the spirit and feeling which render them effective and pleasing.

Grecian Mouldings.

The leading outline of Greek moulding is the gracefully flowing cyma. This will indeed be found to enter into the composition of almost every thing that diverges from a right line; and even combinations of mouldings are frequently made with this tendency. It is concave above and convex below, or the reverse; and though a long and but slightly flected line appears to connect two quickly-curving ends, it will always be found that the convexity and the concavity are in exactly the same curve, so that if the moulded surface were reversed, and the one made to assume the place, it would also have the appearance of the other, and the effect would be the same. It is, in fact, the Hogarthian line of beauty; and it is not a little singular that Hogarth, in his well-known *Analysis of Beauty*, although he did not know, and indeed could not have known, the contours of Greek architectural mouldings, has given the principle of them, and, under his line of beauty, has described many of the finest Greek forms. The Roman and Italian mouldings were called Greek in his day, and he assumed them to be so; but they evidently do not agree with his theory, whereas, in principle, the now well-known Greek forms do most completely.

The cyma-recta is generally found to be more upright and less deeply flected than the cyma-reversa; it is almost always the profile of enrichments on flat surfaces, of foliage, of the covering moulding of pediments, of the undercut or hooked mouldings in antæ-caps, the overhanging not affecting the general principle; and it pervades, as we have said, flected architectural lines generally, whether horizontal or vertical. The cyma-reversa has all the variety of inflection that its opposite possesses, but the line connecting its two ends is, for the most part, more horizontal, and its curves are deeper. It pervades many architectural combinations, but is most singularly evinced in the composition of the Greek Doric capital, which is a perfect cyma-reversa, with the ends slightly but sharply flected, as it flows out of the shaft below, and turns in under the abacus above. The obviousness of the former is prevented by the annulets which divide the cyma into an ovalo and a cavetto, but the principle is clear.[1] The cyma is the governing outline in the congeries of mouldings in bases also, as may be noticed in the Ionic and Corinthian examples quoted and referred to.

Pl. LIII. & LIV. Fig. 6 & 7.

Pl. LV. Fig. 5. Pl. LVI. Fig. 3.

An ovalo is but the upper half of a cyma-reversa, even when it is used as a distinct moulding, and unconnected with the waving form. The name expresses its apparent rather than its real tendency; for its contour is not that of an egg in any section, though the ornament which is carved on it, when used as a running moulding, is formed like an egg; and from that the moulding was named.

Pl. LVII.

The upper torus of a base forms, with the escape or apophyge of the shaft, a perfect cyma, and the scotia and lower torus do the same; so that the torus and scotia are referable to the same principle when in composition, and they are not found together except in the combination referred to.

The bead is an independent moulding, varying in contour; but it is generally the larger segment of a circle. It is used, however, sometimes to mask the waving form, and sometimes to separate it.

The cavetto, or simple hollow, is part of a cyma also, as we have shown; but it is also applied independently, to obviate a sharp angle, or to take from the formality of a vertical line, as in the abaci of Ionic antæ-caps. Its form, nevertheless, is not the segment of a circle, for the upper part of a cavetto is the most flected, and it falls below almost into a straight line.

Grecian Mouldings.

There is a hooked moulding common in Greek architecture, particularly in the Doric antæ-caps, which is technically called the hawk's-beak. It is a combination of curves which cannot be described in words; but it has been already referred to in speaking of the cyma-recta, which is brought into its composition.

Pl. LIII. Fig. 5 & 11 Pl. LIV. Fig. 5 & 10.

The cyma-recta is never found carved, or sunk within itself; but it sometimes has the honeysuckle, or other ornament of the kind, wrought on it in relief, particularly when used as the covering moulding—the cymatium—of a pediment. The enrichment of the cyma-reversa consists of a contrasted repetition of its own contour meeting in a broad point below, and joining by a circular line above, and making a sort of tongued or leafed ornament, whose surface is inflected horizontally also. Between the leaves a dart-formed tongue is wrought, extending from the circular flexure above to the bottom of the moulding, whose contour it takes in front alone. As this would not mitre or join well on the angles of the cyma, a honeysuckle is gracefully introduced in the manner shown in the example. This enrichment is not wrought in relief on the moulding, but is carved into it, so that the surfaces of the parts of the ornament alone retain the full outline of the cyma. The ovalo is enriched with what is called the egg and dart ornament. This will be best understood by reference to the example. Its angles also are made with a honeysuckle, and the inflections are made in the moulding itself. The torus is sometimes enriched with the interlaced ornament called the guilochos: this too is cut into the moulding itself. We have no Greek example of an enriched scotia, and from its form and position, which, to be effective, must be below the eye, it hardly seems susceptible of ornament which could operate beneficially. The bead is carved in spheres or slightly prolate spheroids, with two thin rings or buttons, dilated at their axes, placed vertically between them. A cavetto is not enriched at all, nor is the hawk's beak, except by painting, which does not appear to have been an uncommon mode of enriching mouldings among the Greeks; that is, the ornament was painted on the moulded surface instead of being carved into it. Fascias are also found enriched by painted running ornaments, such as the fret or meander, the honeysuckle, and the lotus. Sometimes plain colour was given to a member, to heighten the effect it was intended to produce. Ornaments were painted and gilt on the coffered panels of ceilings too.

Pl. LVII.

The few examples which exist of sculptured ornament on straight surfaces exhibit varieties of nearly the same combinations as those last mentioned,—the honeysuckle with the lotus, and sometimes a variety of itself on scrolls, either throwing out tendrils, or plain. This is found on the necking of the Ionic columns of the Athenian Acropolis, and on those of their antæ, and continuing along under the congeries of mouldings, as previously described. The varieties of foliage used in the enrichments of Greek architecture are few, and will be found generally exemplified in the Corinthian capital of the choragic monument of Lysicrates, and in the rich acroteral pedestal or stem of the same edifice, than which we possess no more elaborate specimen of foliated enrichment of the Greek school. There exist many specimens of architectural ornament on vases and fragments, in marble and terracotta,

Pl. LVI. Fig. 3. Fig. 1.

[1] The presence of the cyma in the Doric capital was, we believe, first pointed out by Mr T. L. Donaldson, in the supplementary volume to the new edition of Stuart's *Athens*, though the true contour of the cyma itself appears to have escaped that gentleman's attention.

Roman Structures.

in which human figures, both male and female, are composed, with a greater variety of foliage than is generally found in Greek architectural works; and many of the beautiful marble and bronze utensils discovered in Herculaneum and Pompeii have enrichments obviously of Greek origin, from which, as well as from the specimens of ornament on positive architectural monuments, we may judge of their productions generally, as well as acquire or imbibe somewhat of the fine taste which originated them.

It would be puerile to speculate on the domestic edifices of the Greeks any further than we have done, as we possess no genuine data on which to proceed. Their sacred structures have taught us their style of architecture; but for its application to general purposes we have no resource but to consult the Roman remains of the exhumated Campanian cities and other places, and gather from analogy what Greek domestic architecture was.

Of Roman Structures.

Temples and other public buildings.

With a treatise on Roman architecture by a Roman architect, in our hands, mere transcription would appear to be all that is necessary in writing on the subject. But finding the writer and existing specimens of the art at variance, we cannot help determining in favour of the superior authority of the latter; to which, therefore, we shall refer to elucidate Roman edifices and the Roman style, as we did to the Greek remains to elucidate the Grecian.

Though far inferior in simplicity and harmony to the columnar architecture of the Greeks, that of the Romans, whether derived from it or not, is evidently of the same family, and is distinguished by boldness of execution and elaborate profusion of ornament. The tastes of the two nations are exemplified in the Doric of the former and the Corinthian of the latter; the one a model of simple grandeur, perfect in its peculiar adaptation, but almost inapplicable to any other purpose; and the other, less refined, but more ornate, making up in extrinsic what it wants in intrinsic beauty—imperfect in every combination, but almost equally applicable to every purpose. As in Greece, so also in Rome, the noblest specimens of columnar architecture are in the temples of the divinity; but it does not appear that the Romans were in the habit of constructing them peripterally, as the Greeks so constantly did. There are indeed ruins which induce the belief that they at times built dipteral temples; but their common practice (as far as existing examples are authorities) was to make them pseudo-peripteral, or apteral and prostylar: of an amphiprostyle, even, we have not an example. It certainly is the custom to restore the ruined temples, whose remains are a few columns only, as if they had been peripteral; but it is done not only without sufficient authority, but against that which the more perfect structures present. The great projection, too, that the Romans gave their porticoes, is evidence that they were dependent entirely on themselves for effect; for they are generally projected three columns and their interspaces before the cella, which, however, has no pronaos with columns in antis; nor does it appear from existing remains that the Romans were accustomed to use that arrangement. Circular or peristylar temples are not uncommon in Roman architecture; and there are temples to which it can hardly be supposed that columns were ever attached: these are for the most part polygonal. Neither do the Romans appear ever to have constructed hypæthral temples with columns internally, as the Greeks did. Indeed it is a question whether all their temples were not cleithral; for it is not generally admitted that the Pantheon, which is hypæthral by the open eye of the dome, was originally a temple; and where the structures remain tolerably perfect, the ceilings and roofs appear to have been formed by arching from flank to flank, and thereby quite inclosing them.

Pl. LIII. & LIV.

Pl. LVIII.

The application of columns internally is most strikingly effective in the Pantheon, where they are arranged in front of niches, or deep recesses, composed with antæ to carry a crowning entablature round under an attic on which the cupola rests. No representation can convey even the most incompetent idea of the effect of this arrangement, to those who cannot gather it from the plan. A section presents only one compartment correctly; all the rest must of necessity be foreshortened. It is far otherwise with the temple of peace and the hall of the baths of Diocletian, in which columns stand before the piers to have the entablature broken over them. This, indeed, was the result, as we have before intimated, of the combination of columns with arches; and it is most clearly exemplified in those works which most probably originated the practice, and which are next in pretence to the temples:—these are the triumphal arches.

Pl. LX. Fig. 4 & 5

The Romans had not adopted the simple graduated stylobate of Greek columnar architecture in their temples, but made the access to their porticoes in front with thin steps, and built vertical stereobates along the flanks for the walls of the cella, or as stylobates, if there were attached columns. In applying a columnar arrangement to the triumphal arch, this lofty stylobate was taken also. The breadth of the opening prevented the columns from being placed equidistant; they were, therefore, coupled, the entablature was broken over them, and necessarily the stylobate was cut through, leaving mere attached pedestals to stilt the columns, so that the whole ordinance was deprived of every thing that could render it as a composition beautiful: its simplicity and harmony were entirely gone; and instead of giving a graceful character to the structure, it became a mere attached frontispiece, that could only deform it. As if conscious that the Corinthian was too beautiful to maltreat in such a manner, the Roman architects produced the hybrid, which has since been called the Composite order, to use in these compositions: in them, indeed, it is chiefly found; and if it were not evidently a mere deterioration of the Corinthian, it might with truth and propriety be called the Roman order.

Fig. 6, 7, & 8.

Fig. 10 & 11.

Pl. LIX. Ex. 2.

Coupled columns, broken and recessed entablatures and pedestals, and the Composite order, are among the greatest blemishes in Roman architecture; for the misformed and inappropriate abortions which have obtained the name of Ionic and Doric, in Roman works, are hardly to be attributed to the school, but to individuals of it, as they are of very infrequent occurrence, and generally appear only in works which are otherwise ungainly. Such are the amphitheatres, whose elliptical forms can never be graceful, and whose architecture was invariably the worst the time produced. The immense structure in Rome, which, from its magnitude, has been called the Colosseum, bears in relief the gross architectural solecism of columns in stories, which, moreover, have recessed stylobates and immense intercolumniations, with large arches in them, which again reduce the effect of the column still more, making the continuity of the entablatures themselves a fault, by their consequent infirmity. The architectural details of this structure are coarse and inelegant, plain without simplicity, and laboured without elegance. But internally these blemishes disappear, columns and arches piled upon columns and arches give way to the long continuous lines which graduated from the arena to the gallery, and must have produced as grand an effect as almost any object in architecture: its magnitude and ruined state produce the imposing effect so striking at the present time; but the mind can easily restore it, or it may

Ex. 3 & 4.

Pl. LX. Fig. 1.

Roman Structures.

be contemplated in miniature in the amphitheatre at Verona.

The most perfect specimens of the Roman theatre remaining are those of Pompeii and Herculaneum. Like those of the Greeks, they rest on the side of a hill; but instead of being hewn out of, they are built on it, as there is no rock out of which they might have been excavated. Their general form, however, is very similar to that of the Greek theatre, but they received a greater degree of architectural decoration than the latter was susceptible of. Of this the theatre of Marcellus in Rome is an example; for though otherwise destroyed, its external wall remains, and presents columnar ordinances, with intervening arches in stories, according to the vicious and inelegant practice of the Roman school. This, however, is on a plain, and presents external walls, which other examples do not so completely.

The baths of the Romans were structures of immense extent, and of splendid appearance internally. What their exteriors were we have no competent means of determining; fragments, however, give us reason to believe, that in architectural merit they did not surpass the exteriors of the amphitheatres. The walls internally were covered with stucco, and painted with foliage, figures of animals, and compositions, architectural landscape or history: the floors were of mosaic, laid in compartments, and variously ornamented: the ceilings were vaulted and stuccoed like the walls; sometimes they were enriched with coffered panels containing sculptured flowers or other architectural ornament, and sometimes they were merely painted with what are termed arabesques. Columnar ordinances do not appear to have been much used, and when they were, it was not always with good taste, as we have had occasion already to remark; though the structure called the Pantheon, which, with a great show of probability, is believed to have been a saloon in the baths, perhaps of Agrippa, on the contrary presents a beautiful adaptation of one. That the Pantheon was part of a more extended edifice, is very clear from its external form and appearance, which are unsightly in the extreme, presenting a mis-shapen and unfinished mass. Now, domed chambers are very common in the baths and palaces of the Romans. They are not only more effective than rectangular apartments, but were much more convenient in the absence of glass; for a small opening left in the apex lights and ventilates the domed saloon most completely, whilst the rain that could pass through it was necessarily small in quantity, and could be easily avoided by those walking on the floor. In rectangular vaults this could not be effected, so that rooms of that form depended on lateral openings for light and air, and were thereby exposed and uncomfortable. Again, there is a rectangular portico attached to the Pantheon, having no single feature in common with it, the former being a noble Corinthian octaprostyle of three intercolumniations projecting, with two others of antæ and pilasters behind; and the other a polygonal, bulbous mass of brickwork, much loftier than the portico, having cornices and blocking courses, too, none of which range with the entablature or any part of it. A conclusive argument, moreover, against the commonly received opinion, that the portico and the circular temple are an original composition, proving indeed that the former was an adaptation of what most likely had previously existed elsewhere in a different situation, and of course could not be intended for its present adjunct, is, that it now fronts north, and consequently the sun never shines full on it, so that it is in fact always in shadow; and that was never permitted even by the Romans in their original compositions; for two-thirds of the beauty of a portico, consisting in the beautiful play and contrast of light and shade it affords, are thus sacrificed. But in an after-appropriation, as we imagine in this case, it might have been, and clearly was done; probably through the ignorance or inattention of those who did it. If, then, the Pantheon, whose diameter is nearly 150 feet, was but an apartment—suppose the grand saloon or xystum—in the baths, the whole structure must have been immense; and if its proportions and internal architecture be taken, as they certainly may be, as a specimen of the style and manner of the interior of the edifice generally, we shall obtain a very high opinion of the magnificence of the Roman baths or thermæ. That they were adorned with admirable works of sculpture, too, is proved by the fact, that some of the noblest specimens of that art have been discovered in, and among the ruins of, the baths in Rome. It may be further remarked of the Pantheon, that its effect has been seriously injured since its original construction, by the removal of the columns from the recess opposite to the entrance, making the opening greater, fixing the columns before the antæ with the entablature broken round them, and turning an arch over the whole; thus destroying, as far as that part could affect it, the simplicity and perfect harmony of the primitive composition. The same bad taste which dictated that alteration affixed little pedimented excrescences, now used as altars, against the piers which alternate with the compartments of columns.

Fig. 2 & 3.

Fig. 4 & 5.

Palaces and villas

The still extensive remains of the villa of Adrian, near Tivoli, bespeak its original magnificence; and the architectural fragments with which the site even now abounds, though it has furnished specimens to almost every country in Europe, after having suffered the spoliation and destruction attending the incursions of barbarians and the lapse of so many centuries, attest its pristine beauty, and the fine taste of its imperial builder. This, however, furnishes no evidence that its exterior was attractive. Everything appears to have been directed to internal splendour and effect alone; and indeed all collateral evidence tends to the conclusion, that the exterior of Roman palaces and mansions was not heeded; being merely plain brick walls. This is the case at Pompeii, as we shall see; and the ruins of mansions in various parts of Italy, from that of Sallust on the Benacus or Lago di Garda, to those of other Roman nobles on the shores of the Bay of Baiæ, present no indications whatever that their exteriors were subjected to architectural decoration. The palace of Diocletian at Spalatro, and the splendid remains of Balbec and Palmyra, some of which perhaps belonged to secular structures, offer evidence to the contrary of this, if they are correctly restored in the works which treat of them; for they present in their elevations so many of the worst features of the Italian school, that there would be room for doubt, if views of the ruins did not help to justify the restorers. But this does not appear to have been the case in the earlier ages of the empire, when architecture among the Romans was in its best state. Notwithstanding the extent of the structure, and its general magnificence, however, the mouldings and ornaments in the interior of the villa of Adrian, though in themselves classical and elegant, are small, and have a general air of littleness, especially when compared with the apartments to which they belong;—not that the apartments are generally large, but they are for the most part lofty. The ceilings appear to have been formed by vaulting; there are no indications of windows, and none of stairs of any magnitude—so that the rooms must have been nearly if not quite open at one end, to admit light and air; and the probability is that there were no apartments above the ground floor, though it is likely enough that terraces formed on the vaulted roofs were used for the purposes of recreation and pleasure. The floors were of mosaic, several of

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which are preserved entire in the Museum of the Vatican; and many fine specimens of ornamental sculpture in vases and candelabra, besides busts, statues, and groups in bronze, marble, porphyry, and granite, of various styles, the remains of the noble collection Adrian made during his progress through his extensive dominions, found among the ruins of the villa, are conserved in the same place.

The ruins of the palace of the Cæsars present no forms or arrangements from which it would be possible to form a rational notion of its original plan, still less of its general elevation, or indeed of the elevation of any part of it. Large vaulted apartments, with here and there a little stucco, sometimes moulded and sometimes plain or merely painted, and a few small unconnected chambers scattered up and down in a mountain of brick rubble, convey an exceedingly vague idea of a palace, or rather they are incompetent to convey an idea of a palace at all.

Roman streets.

If evidence were required to prove the futility of written descriptions of buildings when their general model is unknown, it would be enough to compare the house of a Roman gentleman in Pompeii with the various designs which have been made of the same thing from the descriptions and directions of Vitruvius, before the exhumation of that city. Their authors could only work upon the notion they had of laying out houses; and therefore the plans produced are those of ill-contrived modern residences, so arranged that they may present a uniform and architectural external elevation, which the Roman houses have not; with windows properly lighting every apartment, which are totally wanting in the latter; with staircases to upper stories that did not exist; with corridors and doors uniformly disposed, which was unheeded in laying out a Roman house. The Vitruvian restorers put columns wherever they could, whereas the Roman architects appear only to have put them where they could not avoid it. In dimensions, too, the former erred no less than in distribution; they thought none too extensive for a Roman domicile: but the apartments in Roman houses, wherever they are, are generally small, and in ordinary cases their whole site is exceedingly restricted. In proportioning the various parts, they adhered to rules the Romans never heeded; and applied the details of the architecture of temples and triumphal arches to domestic edifices, in whose composition the plasterer, painter, and mason, almost appear to have been the only architects!

Far inferior as Pompeii was to Rome in magnitude and splendour, there is no more reason for supposing that houses in the latter were so very differently arranged from those in the former that the same general description of them should not apply to both, than there would be for a future antiquary to hesitate in applying the plan of a Brighton or Bath house, which may be preserved, to a London mansion; for we know that in ordinary cases they nearly coincide. It is, too, a recorded fact, that wealthy Roman citizens had mansions at Pompeii and Herculaneum; and we have already stated that discoveries made of ordinary houses under the present level of Rome show them to be exactly like the more perfect ones of the Campanian city, except in their state of preservation; so that, "*parvis componere magna*," in Pompeii we may see the domestic as well as public architecture of ancient Rome.

The streets of Pompeii are very narrow, their average width being not more than twelve or fifteen feet; frequently they are not more than eight feet wide, and very few in any part exceed twenty. The principal excavated street in the city, that leading from the Forum to the gate towards Herculaneum and the street of the tombs, is, at the widest, twenty-three feet six inches, including two footways, each five feet wide. The streets are all paved with lava, and almost all have side pavements or footways, which, however, are for the most part so narrow, that, with few exceptions, two persons cannot pass on any of them. That the cars or carriages of the inhabitants could not pass each other in most of the streets, is proved by the wheel-ruts which have been worn on the stones, and the recesses made here and there for the purpose of passing. Their narrowness and inconvenience are aptly exemplified in London by the narrow lanes which come between St Paul's and Thames Street, about Doctors' Commons. The Forums, on the contrary, though not very spacious, are of regular forms, and have wide and convenient footways, completely colonnaded. In immediate connection with them are the theatres, the principal temples, the basilica, the courts of justice, and other public edifices: the amphitheatre is by itself, in an extreme angle of the city. The use of some of the buildings on one flank of the great Forum is not obvious: they are not arranged like temples, and indeed possess no peculiar character by which they may be distinguished: it is tolerably clear, however, from circumstances, that they were for the use of the public. The temples differ very little from the ordinary Roman structures of that description, but are generally inferior to them in the quality of the materials of which they are constructed, in the style of their architecture, and in the manner of its execution. The basilica is not unlike a modern church, it being a long rectangular edifice, having an arcaded porch at one end, being divided internally by rows of columns into nave and aisles, and having a columned recess at the west end of the nave for a tribunal. There are, however, no indications of windows, so that it was probably hypæthral, though that arrangement would have made the place very inconvenient for its purpose.

Pl. LXI. Fig. 1.

The streets of Pompeii are lined on either side with small cells, which served for shops of various kinds; and they are strikingly like the ordinary shops in towns in the south of Italy and in Sicily at the present time. Like these, too, there appear in very few cases to be accommodations in connection with the shops for the occupiers and their families, who must have lived elsewhere, as modern Italian shopkeepers very commonly do. They present no architectural decoration whatever; the fronts are merely plain stuccoed brick walls, with a large square opening in each, part of which is the door, and part the window, for lighting the place and showing the goods. Fig. 3.

Houses and domestic accommodations.

Whenever a private house or gentleman's mansion occurs in a good place for business, like the ground floor of many modern Italian noblemen's palaces, the street-front, or fronts, was entirely occupied with shops, a comparatively narrow entrance being preserved to the house in a convenient part between some two of them. The door to this is sometimes quite plain, but at times it is decorated with pilasters. When the site permitted such an arrangement, the entrance door being open, a passer by could look completely through the house to the garden, or, in the absence of a garden, to the extreme boundary wall, on which was painted a landscape or other picture. An arrangement, it may be observed, not unlike this, is common in some of the Italian cities at the present day; but the mansions being now built in stories, and the upper stories alone being occupied by the families, a merely pleasing effect is produced; whilst in the former, persons crossing from one apartment to another were exposed, and domestic privacy thus completely invaded to produce a pretty picture. Within the entrance passage, which may be from ten to twelve feet in depth, there is a vestibule or atrium, generally square, or nearly so, on which various rooms open, that vary in size from ten feet square to ten feet by twelve, or even twelve feet square: they

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have doors only, and were probably used as sleeping-chambers by the male servants of the family. In the centre of this court there is a sunk basin or reservoir for receiving the rain, called the compluvium, rendering it likely that this was roofed over, with a well-hole to admit light and air, and allow the rain to drop from the roof into the reservoir. Connected with this outer court was the kitchen and its accessories. If the site allowed the second court to be placed beyond the first in the same direction from the entrance, the communication was by a wide opening not unlike folding doors between rooms in modern houses, generally with a space intervening, which was variously occupied; if the site did not allow of that arrangement, a mere passage led from one to the other. The second or inner vestibule, atrium, or court, is generally much larger than the first, is for the most part parallelogramic, but variously proportioned. It forms a tetrastoön, being open in the middle and arranged with a peristyle of columns, colonnading a covered walk all round. On this the best and most finished apartments open; but they are of such various sizes, and are so variously arranged, that it is not easy to determine more than that they included the refectory, the library, and sleeping-rooms. Some of them, indeed, are such as must have been useless except for the last purpose: these, perhaps, were the apartments of the female branches of a family, at least in most cases. Some houses, however, have a nest of small cells in an inner corner or secluded recess, which may have been the gynæceum; but that is far from being common. Exhedræ or recesses, open in front to the atrium, are common, and are often painted with more care and elegance than any other part of the house; but generally the walls are everywhere painted—in the more common places flat, with a slight degree of ornament perhaps, and in the best rooms with arabesques and pictures in compartments. The architectural decorations are mostly painted: the ornaments are not unfrequently elegant, but the architecture itself of the mansions is bad in almost every sense. The rooms being windowless, would, when covered, be necessarily dark; the doors are arranged without any regard to uniformity, either in size

Fig. 8.

or situation. The street-fronts of those houses which, not being in a good business situation, were not occupied with shops, were not merely unadorned, but were actually deformed by loop-holes to light some passage or inner closet which had no door on one of the courts. The columns of the second courts are generally in the worst style possible: those which have foliated capitals, and may be considered compositions of the Corinthian order, are the best; but the imitations of Doric and Ionic are both mean and ugly. From the duty they had to perform, and the wideness of their intercolumniations, together with the fact that none of them remain, it is probable that the entablatures were of wood, and were consequently burnt at the time of the destruction of the city, and broken up by the inhabitants, almost all of whom certainly escaped, and who, it is very evident, returned, when the fiery shower and the conflagration had ceased, to remove whatever they could find of their property undestroyed; for it must be remembered that the roofs and ceilings all over the city are entirely gone, and the uncovered and broken walls remain, from eight to ten feet only in height. Every thing, indeed, clearly demonstrates that great exertions were used to recover whatever was valuable; and it is very probable, moreover, that the place was constantly resorted to by treasure-seekers for perhaps centuries after the calamity occurred. It may also be remarked that the loftier edifices, which would have been unburied by the ashes, had been thrown down by a terrible earthquake about sixteen years before the volcanic shower fell, and therefore were the more easily covered. Other showers must have fallen since that which destroyed the city, to produce the complete filling up of every part and the general level throughout; as the one must have been prevented by those roofs and ceilings which were fire-proof in the first instance, and the other would be the result of the same, if it were not deranged by the subsequent excavations. It is indeed the fact, that the superstrata of ashes are evident and unbroken, while the substratum is mingled with ruins. Hence we are still uninformed as to the structure and disposition of the roofs and ceilings of the houses of the ancients. The doors, too, of whatever materials they were composed, are entirely gone: there remain, however, here and there, indications of wooden door-posts—in some cases, indeed, charred fragments of them—but they are to outer or street-doors, leaving it probable, as we have before suggested, that a matting of some kind, suspended from the lintel, formed the usual doors to rooms,—or perhaps they were closed by curtains only. In these particulars, unfortunately, Herculaneum affords but little assistance, as the mode of its destruction was similar to that of Pompeii, and it, too, was doubtlessly exposed in nearly the same manner; its subterranean situation, moreover, at present, renders it difficult to examine; but, upon the whole, Herculaneum is more likely to furnish information on these particulars than its sister in misfortune. Although it has been ascertained that the Romans understood the manufacture of glass, or at least that they possessed some utensils of that material, it must not be supposed that they were accustomed to apply it to exclude the weather and transmit light; for in no case has a glass window of any kind been discovered in any ancient structure; and, without contemplating the houses of Pompeii, it is impossible to appreciate the advantages we derive in our habitations from the application of that beautiful production of the useful arts, and how much superior it alone renders them to those of the ancients. The floors of the houses of Pompeii and Herculaneum are all of mosaic work, coarser and simpler in the less esteemed parts, and finer and more ornate in the more finished apartments: the ornaments are borders, dots, frets, labyrinths, flowers, and sometimes figures. In this, too, the superior advantages the moderns enjoy are evident. The ancients did not understand how to construct wooden floors, at least the application of timber to that use was not made by them; for, though it were admitted, which, however, it cannot be with justice, that, in the warmer climate of the south of Italy, paved floors would be more grateful, that would not be the case in this country; and we find the remains of Roman houses, baths, &c. in England, with floors of mosaic, as in Naples and Sicily. All the indications which are found in Pompeii of an upper story consist in a few rude and narrow staircases, which, it is very probable, were to afford access to the terraces or flat roofs, for they are not common, and no portion of an upper story remains in any part, though it is most likely that the lower or ground-floor rooms were arched over. In one part of the city the houses on one side of a street are on a declivity: there a commodious flight of stairs is found to lead from the atrium in front, to another atrium and rooms below, not under the houses, but behind them; for neither do we find an under-ground or cellar story in the Pompeian houses. On the shores of the Bay of Baiæ, and of the Gulf of Gaeta, at Cicero's Formian Villa, however, there are crypts or arched chambers under the level of the mansions; for the sites require substructions; but it may be questioned whether even these were used as parts of the house, and as we use cellars; for they present no indications of stairs, and have no regular means of intercommu-

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nication. Neither had the houses of the Romans chimneys of any kind; their only mode of warming their apartments was by means of braziers, many specimens of which have been taken out of both Herculaneum and Pompeii; and their cooking fires were on fixed gratings over a sort of stove, but without flues; so that most probably charcoal alone was burnt for domestic purposes. In this respect the modern Italians are not far beyond their predecessors; and the mode used by them of applying fire in warming and cooking appears very similar to that used by the Romans. Indeed many of the peculiarities we have noticed in the Pompeian houses are still found in various parts of Italy and Sicily; the cortili, courts, or cloisters of palaces, mansions, monasteries, and inns, are representatives of the cavædia, vestibula, atria or courts, of Pompeian or Roman mansions. It is common, too, in the former, for bed-rooms to open on open galleries, as on the colonnaded courts of the latter. There are instances also in the countries referred to, of rooms which have no aperture but the doorway. Shops, we have said, are frequently mere cells, having an opening towards the street, part of which is a door, and the other part, with a low dado, a window. It was only in the forums and public places, then, that architectural beauty and magnificence were displayed in a Roman city. Street architecture was unknown, and the decoration of houses was the work of the plasterer and painter rather than of the architect.

If such as we have described were the imperfections and inferiority of the domestic architecture of the Romans, who knew that of the Greeks and Egyptians, and had, moreover, knowledge of the use of the arch, and were, we have reason to believe, better carpenters than either, besides possessing greater wealth, and a greater taste for luxury than they, with a less mild and serene climate than Greece and Egypt,—what must the domestic edifices of these nations have been! A person accustomed to the comforts and conveniences of houses in this country finds much to complain of in a modern Italian mansion, but not so much as an Italian would in the house of an ancient Roman; and from analogy we may believe that a Roman of the empire would have had reason to complain of a Grecian domicile, even of the Periclean age; and a Greek, again, might have been abridged of the comforts of his house in the palace of an Egyptian.

Superior as the habitations of civilized men in modern times may be to those of the ancients, a degree of classic beauty and elegance pervaded the decorations and furniture, and even the domestic utensils, in the houses of Pompeii and Herculaneum, which we do not equal, though we imitate them; and from the Hellenic taste which reigns in their forms and enrichments, their origin may probably be attributed to Greek artists; so that, it may be supposed, in these particulars the Greeks even excelled the Romans. It is indeed not a little singular, that though the architecture of these cities is completely Roman, the painted ornaments and ornamental sculpture generally are in style and manner perfectly Greek. There are certainly modifications found of Greek Doric columns in Pompeii; but they bear so slight a degree of relationship to their original, that its existence may almost be denied,—they have the form without the feeling.

Sepulchral monuments.

As works of architecture, the sepulchral monuments of the Romans were of more importance than their domestic structures. There is more architectural display in the street of the tombs at Pompeii, than in any street of the city itself; and the mausoleum of Adrian on the right bank of the Tiber at Rome was a much more important object in its perfect state than his villa near Tivoli could ever have been. It was perhaps the most splendid structure of the kind ever executed; excelling the Memphian pyramids as much in architectural pretence as they surpass it in magnitude. There was, too, a degree of harmony and simplicity in its composition, which can only be accounted for by supposing that the imperial builder, who was himself an adept in architecture, had acquired better taste than the architects of Rome generally possessed, by the contemplation of the monuments of Greece and Egypt. It consisted of a deep quadrangular basement, each of whose sides was about 250 feet in length. This was surmounted by a lofty circular mass, on which was a graduated stylobate, supporting a noble peristyle of Corinthian columns, with their entablature; forming, with its circular cone, a species of peristylar temple, something like that below the cupola of St Paul's Cathedral in London. Above this there was, most probably, a species of dome, whose acroterium is said to have been a metal pine-cone, which was the receptacle of the ashes of the emperor. The mausoleum of Augustus was, we may believe, from the descriptions which exist of it when in a more perfect state than it is at present, inferior in size, in splendour, and in good taste, to that of Adrian; but it was nevertheless a magnificent monument. Its form was conical; it diminished in stories and terraces, probably columned round, and terminated at the apex in a bronze figure of its founder. The sepulchral monuments of Cecilia Metella, of the Plautian family, and others, are evidences of the same fact. The sarcophagus from the first-mentioned of these is simple and elegant in the extreme; and indeed it exhibits a greater degree of simple beauty than almost anything of the same kind that remains to us of the Romans.

Roman Corinthian

Of the Roman Corinthian.

Like the Greek orders, the Roman Corinthian may be said to consist of three parts, stylobate, column, and entablature; but, unlike them, the stylobate is much loftier, and is not graduated, except for the purposes of access before a portico. Its usual height is not exactly determinable, in consequence of the ruined state of most of the best examples; but it may be taken at from two and a half to three diameters. In the triumphal arches the height of the stylobate sometimes amounts to four, and even to five diameters. It is variously arranged, moreover, having, in the shallower examples, simply a congeries of mouldings to form its base, with perhaps a narrow square member under it, a plain dado, and a covering cornice or coping, on the back of which the columns rest. In the loftier examples a single, and sometimes a double plinth, comes under the base mouldings; and a blocking course superimposes the coping, to receive the bases of the columns. This last is only necessary when the height of the stylobate is such as to take the columnar base above the human eye, when the coping cornice would intercept it if a blocking course did not intervene. Pl. LX. Fig. 6, 8, 9, & 10.

The column consists of base, shaft, and capital, and varies in height from nine and a half to ten diameters. The base has, ordinarily, in addition to the diminishing congeries of mouldings which follows the circular form of the shafts, a square member or plinth, whose edges are vertical: with this the whole height of the base is about half a diameter. The rest of this part of the column is variously composed, but it generally consists of two plain tori and a scotia, with fillets intervening, as in the Greek examples of this order, but differently proportioned and projected, as the examples indicate. Sometimes the scotia is divided into two parts, by two beads with fillets, as in the Jupiter Stator example, in which also a bead is placed between the upper torus and the fillet of the apophyge. The spread of the base varies from a diameter and one third to a dia- Pl. LVIII. Ex. 1.

Roman Corinthian.

meter and four ninths. In the best Roman examples, as well as in the Greek, the shaft diminishes with entasis: the average diminution is one eighth of a diameter. The shaft was always fluted when the material of which it was composed did not oppose itself; for the Romans often used granites, and sometimes an onion-like marble called therefore *cipollino*, for the shafts of columns; the former of which could not be easily wrought and polished in flutes, and the latter would scale away if it were cut into narrow fillets. Like the Greek Corinthian and Ionic orders, the Roman Corinthian has twenty-four fillets and flutes. The flutes are generally semicircles, and they terminate at both ends, for the most part, with that contour. Dividing the space for a fillet and a flute into five parts, four are given to the latter, and one to the former. The hypotrachelium is a plain torus, about half the size of the upper torus of the base, or half the width of a flute, as these nearly correspond: it rests on a fillet above the cavetto at the head of the shaft.

The ordinary height of the capital is a diameter and one-eighth; but there is a very fine example in which it hardly exceeds a diameter, and another in which it is not quite so much. It is composed of two rows or bands of acanthus leaves, each row consisting of eight leaves ranged side by side, but not in contact; of helices and tendrils trussed with foliage; and an abacus, whose faces are moulded and variously enriched. The lower row of acanthus leaves is two-sevenths the whole height of the capital; the upper row is two-thirds the height of the lower above it, and its leaves rest on the hypotrachelium below, in the spaces left between the others. They are placed regularly, too, under the helices and tendrils above, which support the angles, and are under the middle of each side of the abacus. The construction and arrangement of the next compartment above must be gathered from the examples; for a competent idea cannot be conveyed in words. The abacus is one-seventh of the height of the capital; in plan it is a square whose angles are cut off, and whose sides are concaved in segments of a circle, under an angle at the centre of from 55° to 60°. Its vertical face is generally a flat cavetto, with a fillet and carved ovalo corbelling over at an angle of about 125°. The cavetto is sometimes enriched with trailing foliage, and a rosette or flower of some kind overhangs the tendrils from the middle of each side of the abacus.

Every example of this order differs so much in the form, proportion, and distribution of the various parts, of its capital particularly, that it cannot be described in general terms, like the Greek Doric and Ionic: the example
Ex. 1. we have referred to in this definition is that of the Jupiter Stator, the most elegant, perhaps, of all the Roman specimens.

The entablature varies in different examples from one diameter and seven eighths to more than two diameters and a half in height. Perhaps the best proportioned are
Ex. 4. those of the portico of the Pantheon, and of the temple
Ex. 3. of Antoninus and Faustina; the former being rather more than two diameters and a quarter, and the latter rather less than that ratio. The entablature of the temple of Jupiter Stator is more than two diameters and a half in height, of which the cornice alone occupies one sixth more than a full diameter, leaving to the frieze and architrave somewhat less than one diameter and a half between them. In this latter particular it nearly agrees with the other two quoted examples, so that the great difference in the general height is in the cornice almost alone, the cornices of the others being about a sixth less, instead of as much more, than a diameter in height. The Roman Corinthian entablature may be taken, then, at two diameters and a quarter in height. Rather more than three fifths of this is nearly equally divided between the architrave and frieze, the advantage, if any, being given to the former; the cornice, of course, takes the remaining two fifths, or thereabouts. The architrave is divided into three unequal fascias and a small congeries of mouldings, separating it from the frieze. The first fascia is one fifth the whole height; one third of what remains is given to the second, and the remainder is divided between the third fascia and the band of mouldings,—two thirds to the former, and one to the latter. A bead, sometimes plain and sometimes carved, taken from the second fascia, which is itself enriched in the Jupiter Stator example, marks its projection over the first; and a small cyma-reversa, carved or plain as the bead may be, taken from the third fascia, marks its projection over the second. The band consists of a bead, a cyma-reversa, carved or plain according to the general character of the ordinance, and a fillet. In non-accordance with the practice of the Greeks, the face of the lowest or first fascia of the architrave, in the Roman Corinthian, impends the face of the column at the top of the shaft, or at its smallest diameter; and every face inclines inwards from its lowest face up. The whole projection of the architrave, that of the covering fillet of the band, is nearly equal to the height of the first fascia. The frieze impends the lowest angle of the architrave. Its face is either perpendicular, or it slightly inclines inwards, like the fascias of that part of the entablature: in some cases it is quite plain, and in others is enriched with a foliated composition, or with sculptures in low or half relief. The cornice consists of a deep bed-mould, variously proportioned to the corona; but it may be taken generally, when it has modillions, at three fifths, and when it has none, at one half the whole height. It is composed of a bead, an ovalo or cyma-reversa and fillet, a plain vertical member, sometimes dentilled, another bead, and a cyma-reversa and fillet or ovalo, as the lower may *not* be: this is surmounted, when modillions are used, by another plain member, with a small carved cyma-reversa above it. On this the modillions are placed, and the cyma breaks round them. They are about as wide as the member from which they project, and are about two thicknesses apart. In form they are horizontal trusses or consoles, with a wavy profile, finishing at one end in a large, and at the other in a small, volute; and under each there is generally placed a raffled or acanthus leaf. In proportioning the parts of this bed-mould in itself, one third of its height may be given to the modillion member, and the other two thirds divided nearly equally, but increasing upwards into three parts, one for the lowest mouldings, one for the plain or dentil member, and the third and rather largest portion for the mouldings under the modillion member. The mouldings of this part of the cornice are carved or left plain, according to the character of the ordinance; and its greatest projection, except the modillions themselves, that of the modillion member, is about equal to half its height. The upper part of the cornice,—the corona, with its crown mouldings,—consists of the vertical member called the corona, which is two fifths the whole height;—this, in the examples of the temples of Jupiter Stator and Antoninus and Faustina, is enriched with vertical flutes;—a narrow fillet, an ovalo, and a wider fillet, occupy one third of the rest, the other two thirds being given to cyma-recta, with a covering fillet which crowns the whole. Its extreme projection is nearly equal to the whole height of the cornice.

The ordinance of the temple of Vesta, or of the sibyl Ex. 2.
at Tivoli, whose entablature is the very low one mentioned, is not generally in accordance with the scale we have given, and it must be referred to for its own peculiar proportions.

Roman Corinthian.

Pediments with the Roman Corinthian order are found to be steeper than they were made by the Greeks, varying in inclination from eighteen to twenty-five degrees; but they are formed by the cornice of the entablature in the same manner. Antefixæ do not appear to have been used on flank cornices as in Greek ordinances, in which the cymatium is confined to pediments; but in Roman works it is continued over the horizontal or flank cornice, as we have described; and frequently it is enriched with lions' heads, which were at the first introduced as water-spouts. The planceer or soffit of the corona is, in the Jupiter Stator example, coffered between the modillions, and in every coffer there is a flower. The soffit of the entablature in this order is generally panelled and enriched with foliated or other ornament. The intercolumniation is not the same in any two examples. In the temple of Vesta in Rome it hardly exceeds a diameter and a quarter; in the Jupiter Stator example it is a fraction less than one diameter and a half, in that of Antoninus and Faustina, nearly a diameter and three quarters; in the portico at Assisi, rather more than that ratio; in the portico of the Pantheon, almost two diameters; and in the Tivoli example, a fraction more than that proportion.

The antæ of the Roman Corinthian order are generally parallel; but pilasters are mostly diminished and fluted as the columns. Of two of the existing examples of antæ, in one—that of the temple of Mars Ultor—they are plain, to fluted columns; and in the other—that of the Pantheon portico—they are fluted, to plain columns. The capitals and bases are transcripts of those of the columns, fitted to the square forms.

Ceilings of porticoes are formed, as in the Greek style, by the frieze returning in beams from the internal architrave to the wall or front of the structure, supporting coffers more or less enriched with foliage or flowers. This, however, could only have been effected when the projection was not more than one, or at the most two intercolumniations, if stone was used; and it is only in such that examples exist. Porticoes ordinarily must have had arched ceilings, as that of the Pantheon has, or the beams must have been of wood; in which latter case probably the compartments of the ceiling would be larger. How, in the former, it was arranged we cannot tell, as the arches only remain; and they may not be of the date of the rest of the portico.

Pl. LIX. Ex. 2. The ancient examples of what is called the Composite order do not differ so much from the ordinary examples of the Corinthian as the latter do among themselves, except in the peculiar conformation of the capital of the column. In other respects, indeed, its arrangement and general proportions are exactly those of the Corinthian. The Composite was used, we have said, in triumphal arches, and, in the best ages of Roman architecture, in them alone. The difference in the capital consists in the enlargement of the volutes to nearly one fourth the whole height of the capital, and in connecting their stems horizontally under the abacus, giving the appearance of a distorted Ionic capital. The central tendrils of the Corinthian are omitted, and the drum of the capital is girded under the stem of the volutes by an ovalo and bead, as in the Ionic. Acanthus leaves, in two rows, fill up the whole height from the hypotrachelium to the bottom of the volutes, and are consequently higher than in the Corinthian capital: this difference is given to the upper row. Besides this Composite, however, the Romans made many others, the arrangements and proportions of the ordinances being generally those of the Corinthian order, and the capitals corresponding also in general form, though in themselves differently composed. In these, animals of different species, the human figure, armour, a variety of foliage, and other peculiarities, are found. Shafts of columns also are sometimes corded or cabled instead of being fluted: those of the internal ordinance of the Pantheon are cabled to one third their height, and the flutes of the antæ of that ordinance are flat, eccentric curves. There are fragments of others existing, in which the fillets between the flutes are beaded; some in which they are wider than usual, and grooved; others, again, whose whole surface is wrought with foliage in various ways; and it would be no less absurd to arrange all these in different orders, than it is to make a distorted and hybrid capital the ground-work of an order.

Roman Ionic.

Of the Roman Ionic.

The only existing example of this in Rome, in which the columns are insulated, is in the Temple of Manly Fortune, except that of the Temple of Concord, which is too barbarous to deserve consideration. Its stylobate, like that of the Roman Corinthian, is lofty and not graduated, having a moulded base and cornice or surbase. The column is nearly nine diameters in height; its base is half a diameter in height, and consists of a plinth, two tori, a scotia, and two fillets; the shaft has twenty fillets and flutes, and diminishes one tenth of a diameter; the capital is two fifths of a diameter in height; the volutes, however, dip a little lower, being themselves about that depth without the abacus; the corbelling for the volutes is formed by a bead and large ovalo, half the height of the capital; the latter of these is carved: a straight band connects the generating lines of the volutes, whose ends are bolstered and enriched with foliage; and a square abacus, moulded on the edges, covers the whole. The entablature is rather less than two diameters high; three tenths of this are given to the architrave, the same to the frieze, and the cornice occupies the remaining two fifths. The architrave is unequally divided into three fascias, and a band consisting of a cyma-reversa and fillet; the lowest angle impends the upper face of the shaft of the column. The frieze is in the same vertical line, and is covered with a fillet which receives the cornice; it is also enriched with a composition of figures and foliage. The cornice consists of a bed-mould, two fifths of its height, and a corona with crown mouldings. The bed-mould is divided nearly equally between a cyma-reversa and fillet, a square dentilled member and fillet, and another fillet and ovalo. The corona is two fifths the height of the rest of the cornice; another fifth is occupied by two fillets and a cyma-reversa, and the rest is given to a cyma-recta and crowning fillet. The whole projection is nearly equal to the height of the cornice. The cymatium is enriched with acanthus leaves and lions' heads, and the mouldings of the bed-mould and architrave band are carved. The soffit of the corona is hollowed out in a wide groove, whose internal angles are rounded off in a cavetto, but without ornament of any kind, forming indeed a mere throating. Like the angular capitals of the Greek Ionic, the external volute of this is turned out and repeated on the flank: either that or the abuse of it in the Composite capital gave rise to distortions of this order, in which all the volutes of the capital are angular, and consequently all its four faces are alike. In other respects, however, it does not differ generally from the ordinary Roman examples of Ionic. The Temple of Manly Fortune is pseudo-peripteral, and consequently has neither antæ nor pilasters, nor do ancient examples exist of either.

Pl. LX. Fig. 12.

Pl. LIX Ex. 2.

Pl. LX. Fig. 12.

Of the Roman Doric.

This is even a ruder imitation of the Grecian original than the mean and tasteless deterioration of the voluted Ionic is of the graceful Athenian examples. The specimen of it which is considered preferable to the others is

Pl. LIX. Ex. 4.

Roman Doric.

that of the theatre of Marcellus in Rome. The column is nearly eight diameters in height: it consists of shaft and capital only. The shaft is quite plain, except fillets above and below, with escape and cavetto; and it diminishes one fifth of its diameter. The capital is four sevenths of a diameter high, and is composed of a torus which forms the hypotrachelium, and, with the necking, occupies one third of the whole height. Three deep fillets, with a semitorus or quarter-round moulding, are intended to represent the ovalo and its annulets of the Greek capital. They occupy three sevenths of the rest; the other four sevenths are given to the abacus, three fifths of whose depth is plain and vertical; and the other two is divided between a cyma-reversa and a fillet.

The corona and crown mouldings of the cornice being destroyed, the whole height of the entablature cannot be correctly ascertained; but from analogy it may be taken, with the bed-mould, part of which exists, at about two thirds of a diameter, making, with the architrave and frieze, an entablature nearly two diameters high. Of this the architrave is rather more than one fourth, indeed exactly half a diameter. Three tenths of its depth are unequally occupied by the tænia, regula, and guttæ, the first being rather the widest, projecting more than its own depth, and the second the narrowest. The guttæ are six in number, and are truncated semicones in form. The rest of the surface of the architrave is plain and vertical, impending a point rather within the superior diameter of the column. The frieze is two fifths the whole height of the entablature. A fascia, one eighth of its own height, bands it above the triglyphs, and projects about one third of its depth; the rest of its surface is plain vertically, but horizontally it is divided into triglyphs, which are half a diameter in width, and are placed over the centres of the columns. These are channelled with two full and two hemiglyphs, whose heads are cut square on the outer edge, but inclined downwards at the angle of the glyphs. The space between the triglyphs is equal to the height of the frieze without its plat-band or fascia, making in effect perfectly square metopes. All that can be traced of the cornice is a small cyma-reversa, immediately over the frieze, and a square member with dentils on it. In the example the cornice is completed from that of the Doric of the Colosseum.

The temple at Cora presents a singular specimen of the Doric order, evidently the result of an examination of some Greek examples, but moulded to the Roman proportions and to Roman taste. The columns are enormously tall, but the shafts are partly fluted and partly chamfered for fluting, like the Greek. The capital is ridiculously shallow, but the abacus is plain, and the echinus of a somewhat Hellenic form. The entablature is very little more than a diameter and one third in height, and the architrave of it is shallower even than the capital; but the frieze and cornice are tolerably well proportioned, though the triglyphs in the former are meagre, narrow slips, and the latter is covered by a deep widely projecting cavetto, that would be injurious to even a better composition. Instead of regular mutules with guttæ, the whole of the planceer of the cornice is studded with the latter; but, like the Greek, the triglyph over the angular column extends to the angle of the architrave, which does not appear to have been the practice of the Romans; yet the reason for so doing does not appear to have been understood, for the external intercolumniations are the same as the others.

As far as we have the means of judging, the Romans made the antæ of their Doric similar to the columns, only that they were of course square instead of round; though indeed an attached column appears to have been generally preferred.

Roman Mouldings.

It may, however, be here again intimated, that these two orders, the Ionic and Doric of the Roman school, ought hardly to be considered as belonging to the architecture of the Romans. They are merely coarse and vulgar adaptations of the Greek originals, of which we now possess records of the finest examples. If it were not, therefore, that custom required it, we should have omitted all mention of them, or at least have left them to the Italo-Vitruvian school, to which they properly belong. Yet their meanness and tastelessness, when compared with the Grecian models, will more strikingly show the superiority of the latter, and show, moreover, how the architects of the Italian school must have been blinded by their system, when they fancied such wretched exemplars as those of which we have been speaking to be beautiful.

Of Roman Mouldings and Ornament.

Pl. LVII.

The mouldings used in Roman architectural works are the same as the Grecian in general form, but they vary materially from them in contour. The Roman cyma-recta is projected much more than the Greek, with a deeper flexure; and the two parts or ends seldom correspond, the one being generally larger than the other. On the contrary, the Roman cyma-reversa does not project so much, or at so large an angle with its base, as the Grecian, nor is it so deeply flected as the Greeks made it. The upper or convex part of this moulding is almost always larger than the lower or concave; and it is frequently allowed to finish below in a sharp arris projecting from whatever is below it, and above it abuts upon the horizontal soffit of its covering fillet in a similarly harsh manner. The ovalo of Greek architecture is represented in the Roman style by a moulding whose outline is nearly the convex quadrant of a circle, or a quarter round, and sometimes it is nearly that of the quadrant of an ellipsis. The Roman torus is either a semicircle or a semi-ellipsis; and the bead is a torus, except in its application, and in being smaller, and generally projected rather more than half the figure whose form it bears. The cavetto, in Roman architecture, is nearly a regular curve, being sometimes the concave quadrant of a circle, or indeed the reverse of an ovalo, and sometimes a smaller segment. A Roman scotia is more deeply cut, and is consequently less delicate than the same member in a Greek congeries: its form frequently approaches that of a concave semiellipsis.

This correspondence in general form, and disagreement in spirit, of Greek and Roman mouldings, appear to have arisen entirely from the ignorance or inattention of the Romans to the governing principle of Greek combinations; as we have seen that in these the individual mouldings are not independent, as the Romans made them, but that they take their contour and direction from each other, under a certain pervading outline.

The enrichments of Roman mouldings are for the most part similar to those of the Greek, but less delicate and graceful both in design and drawing. Those of the cyma and ovalo are particularly referred to, but the Romans used others besides. Raffled leaves form a favourite enrichment in the architecture of the Romans: indeed these are hardly less frequent in their works than the honeysuckle is in those of the Greeks. Mouldings were enriched with them; and a raffled leaf masks the angles of carved cymas and ovalos in the former, as a honeysuckle does in the latter. Nevertheless, the honeysuckle and lotus are both found in Roman enrichments, particularly the latter, and perhaps even more than in Greek. It is not uncommon to find examples of Roman architecture completely overdone with ornament,—every moulding carved, and every straight surface, whether vertical or

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horizontal, sculptured with foliage, or with historical or characteristic subjects in relief. This fault is most obvious in those works which exhibit similar bad taste in the general composition. The triumphal arch of Septimius Severus, the little arch of the goldsmiths, and the half-buried ruin called the temple of Pallas, in the forum of Nerva at Rome, are egregious specimens. The entablature of the arch of Titus, too, is overloaded with ornament.

Frieze enrichments, consisting of foliage composed with animals, and a variety of other things, are very common in Roman architecture. Many specimens indeed are not found in existing structures, but there are numerous fragments of entablatures of destroyed edifices which exhibit them in great variety. Their general character is exuberance, and a tendency to frittering, from the variety and incoherence of form in their composition; but their effect can only fairly be judged of when seen in appropriate situations. One existing example of an enriched frieze of the kind referred to, that of the temple of Antoninus and Faustina, speaks strongly in its favour, for nothing can surpass its efficiency and simple beauty; but it must, moreover, be confessed that, when examined in detail, the enrichment is less exuberant, and is composed of fewer parts, than most others of the species to which that example belongs. Architectural ornament, however, is not confined to purely architectural works. We find many beautiful specimens of it on the vases and candelabra which decorated the baths and mansions of the ancient Romans, and whose elegance of form rivals even the beauty and delicacy of their enrichments. Whether these should be referred to the Romans or not, is doubtful; for it has been already intimated, from the style of many of them, both in outline and ornament, which appertain more to the Greek, that they are the productions of Grecian artists; but indeed they belong exactly to neither, for they frequently possess the beauties, and sometimes exhibit the defects, of both. There are existing works, clearly of Roman origin, far inferior in every respect to the objects last mentioned. These are for the most part cenotaphial monuments, sarcophagi, and altars, whose composition, details, and enrichments, are gross and inelegant when compared with the objects alluded to. The difference may arise merely from the inferiority of the artists of the one to those of the other, and not from the difference of their schools; but the prevalence of Greek taste in the superior productions is not the less striking because it was acquired by education, while it is wanting in the inferior, whose authors had not been imbued with the spirit and fine feeling of the Greek style.

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Gothic architecture,—that is, the style which preceded the Pointed,—being for the most part a mere deterioration of Roman, and possessing no peculiar character which can recommend it as a subject for study and imitation that may not be deduced from the Roman style, and Pointed architecture being a genus *per se*, we have thought it better to allow the Italian, or revived Roman style, to usurp its chronological place; as the latter more naturally follows what it pretends to be derived from, than it would follow the Pointed, or than the Pointed would the Roman.

We have already stated that Italian architecture, though professedly a revival of the classical styles of Greece and Rome, was formed without reference to the existing specimens of either, but on the dogmas of an obscure Roman author, and the glosses of the "revivers" on his text. Vitruvius described four classes or orders of columnar composition; and, on the principles which governed him in subjecting to fixed laws all the varieties with which he appears to have been acquainted, they formed a fifth, of a medley of two of his, thus completing the Italian orders of architecture. The school which was founded on the Vitruvian theories has systematized every thing, and laid down laws for collocating and proportioning all the matter it furnishes for architectural composition and decoration. It teaches that columns are modelled from the human figure; that the Tuscan column is like a sturdy labourer—a rustic; the Doric is somewhat trimmer, though equally masculine—a gentleman, perhaps; the Ionic is a sedate matron; the Corinthian a lascivious courtesan; and the Composite an amalgam of the last two! In a composition which admits any two or more of them, the rustic must take the lowest place; on his head stands the stately Doric, who in his turn bears the comely matron, on whose head is placed the wanton, and the wanton again is made to support the lady of doubtful character! But as we in this place are neither apologists for nor impugners of any particular doctrines, we proceed at once to point out the general features of the Italian style; premising only, that, according to the practice of the school, every thing is confined to an exclusive use and appropriation; such columns may be fluted, and such must not; such a moulding may be used here, but not there; and so on. The proportions and arrangements of an order, of any part of one, or of any thing that may come within an architectural composition, are fixed and unchangeable, whatever may be the purpose or situation for which it is required; whether, for instance, an order be attached or insulated, the column must have exactly the same number of modules and minutes in height. It is true that the masters of the school are not agreed among themselves as to those things in which they are not bound by Vitruvius; but every one not the less contends for the principle, each, of course, prescribing his own doctrine as orthodox on the unsettled points.

Mouldings are considered as constituent parts of an order, and are limited to eight in number, strangely enough including the fillet. They are the cyma-recta, cyma-reversa, commonly called the ogive or ogee, the ovalo, the torus, the astragal or bead, the cavetto, the scotia, and the fillet. They are gathered from the Roman remains, but reduced to regular lines or curves, which may be drawn with a rule or struck with a pair of compasses. Arranged according to certain proportions, with flat surfaces, modillions, and dentils, a profile is formed; no two conjoined mouldings may be enriched, but their ornaments, as well as the modillions and dentils, must be disposed so as to fall regularly under one another, and, when columns occur, above the middle of them.

An order is said to be composed of two principal parts, the column and the entablature; these are divided into base, shaft, and capital, in the one, and architrave, frieze, and cornice in the other, and are variously subdivided in the different orders. The Tuscan column must be made seven diameters in height, the Doric eight, the Ionic nine, and the Corinthian and Composite ten. The height of the entablature, according to some authorities, should be one fourth the height of the column, and, according to others, two of its diameters. The parts of the entablature of all but the Doric may be divided into ten equal parts, four of which are given to the cornice, three to the frieze, and three to the architrave; and in the Doric, the entablature being divided into eight parts, three must be given to the cornice, three to the frieze, and the remaining two to the architrave. For the minor divisions a diameter of the column is made into a scale of sixty minutes, by which they are arranged; but this is obviously irrelevant if the whole height of the entablature is determined by Pl. LXII.

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the height of the column, and not by its diameter; in this case, therefore, they must be proportioned from the general divisions already ascertained. Columns must be diminished, according to Vitruvius, more or less as their altitude is less or greater; those of fifteen feet high, or thereabout, being made one sixth less at their superior than at their inferior diameter, and that proportion is lessened gradually, so that columns fifty feet high shall be diminished one eighth only. On this subject, however, many of his disciples controvert the authority of their master; and some of them have fixed the diminution at one sixth of a diameter for columns of all sizes in all the orders. The entasis of columns is disputed also, some authorities making it consist in preserving the cylinder perfect one quarter or one third the height of the shaft from below, diminishing from thence in a right line to the top; while others, following Vitruvius, make the column increase in bulk in a curved line from the base to three sevenths of its height, and then diminish in the same manner for the remaining four sevenths, thus making the greatest diameter near the middle.

It being difficult to determine among the masters of the Italo-Vitruvian school whose designs of the various orders are to be preferred, we have selected those of Palladio, certainly not for any superior merit they possess, but because he is more generally esteemed than any other, and because he the most strictly adhered, as far as he could understand them, to the precepts of Vitruvius. It should be remarked, however, that although Palladio has fluted all but the shaft of the Tuscan column, he very seldom fluted columns in his own practice; and indeed it may be called the custom of the Italian school not to flute, how much soever their doctrine may be to the contrary; for fluted columns in Italian architecture are exceptions to the general practice. Swelled or pillowed friezes are not peculiar to Palladio; they are more or less common to the works of most of the masters of the same school. Prostyles being almost unknown in Italian architecture, antæ are not often required; but when they are, the meanest succedaneum imaginable is recurred to. Of this, Palladio's Villa Capra near Vicenza, and Lord Burlington's Palladian Villa at Chiswick, afford striking examples. Pilasters, however, are very common, so common, indeed, that they may be called pro-columns, as they are often used as an apology for applying an entablature. They are described as differing from columns in their plan only, the latter being round, and the former square; for they are composed with bases and capitals, they are made to support entablatures according to the order to which they belong, and are fluted and diminished with or without entasis, just as columns of the same style would be. When they are fluted, the flutes are limited to seven in number on the face, which, it is said, makes them nearly correspond with the flutes of columns; and their projection must be one eighth of their diameter or width when the returns are not fluted; but if they are, a fillet must come against the wall. Pedestals are not considered by the Italo-Vitruvian school as belonging to the orders, but they may be employed with them all, and have bases and surbases or cornices to correspond with the order with which they may be associated. The dado of a pedestal must be a square whose side shall be equal to that of the plinth of the column or pilaster which rests on it, or a parallelogram a sixth or even a fourth of a diameter taller. The intercolumniations of columns are called pycnostyle, systyle, eustyle, diastyle, and aræostyle, and are strictly adhered to in Italian architecture when columns are insulated, and that is not very often; when they are attached, the interspaces are not limited, except when a peculiar arrangement called aræosystyle is adopted. This consists of two systyle intercolumniations, the column that should stand in the mid-distance between two others being placed within half a diameter of one of them, making in fact coupled columns or pilasters. It is applied to insulated columns as well as to those which are attached. Following Vitruvius, the Italian school makes the central intercolumniation of a portico wider than any of the others. Arched openings, in arcades or otherwise, are generally about twice their width in height; if, however, they are arranged with a columnar ordinance, having columns against the piers, they are made to partake of the order to which the columns belong, being lower in proportion to their width with the Tuscan than with the Doric, and so on; and the piers are allowed to vary in the same manner, from two fifths to one half of the opening. With columnar arrangements, moulded imposts and archivolts are used; the former being made rather more than a semidiameter of the engaged columns in height, and the latter exactly that proportion. Variously moulded key-stones are used, too, projecting so that they give an appearance of support to the superimposed entablature. Smaller columns with their entablature are sometimes made to do the duty of imposts, and sometimes single columns are similarly applied; at others, columns in couples are allowed to stand for piers to carry arches. In plain arcades the masonry is generally rusticated, without any other projection than a plain blocking course for an impost, and a blocking course or cornice crowning the ordinance. Niches and other recesses are at times introduced in the plain piers, which are in that case considerably wider than usual, or in the spandrels over wide piers. Very considerable variety is allowed in these combinations, which will be best understood by reference to the examples. Doors and windows, whether arched or square, follow nearly the same proportions, being made, in rustic stories, generally rather less than twice their width in height, and in others either exactly of that proportion, or an eighth or a tenth more. If they have columned or pilastered frontispieces, these are sometimes pedimented; and, except in rustic stories, whether with or without columns, a plain or moulded lining called an architrave is applied to the head and sides of a door or window. This architrave is made from one sixth to one eighth the width of the opening it bounds, and it rests on a blocking course or other sill, as the case may be. In the absence of columns or pilasters in the frontispiece, their place is frequently supplied by consols or trusses of various form and arrangement, backed out by a narrow pilaster, which may be considered as the return of the frieze of the entablature, and supporting the cornice. It is not uncommon for the architrave lining to project knees at the upper angles, and this is sometimes done even with consols and their pilasters. With columned frontispieces to gateways, doors, and windows, arose the custom, so frequent in Italian architecture, of rusticating columns, by making them alternately square and cylindrical, according to the heights of the courses of rustic masonry to which they are generally attached, and with which they are less offensive than in other collocations. The practice of the *Cinquecento* school of piling columns on columns, with their accessories, is warranted by the doctrine of its master; but his precepts not being practicable, recourse has been had to the inferior works of the Romans, which present examples of it. The difficulty of preserving any thing like a rational arrangement is acknowledged on all hands to be great, ir not insurmountable; for if the first or lowest order be at an intercolumniation fitting its proportions, the second or next above it, though diminished ever so little, is already deranged, for it has the same distance from column to column that the inferior order has, whilst the columns themselves are smaller in diameter, and their entablature

Pl. LXVI. Fig. 3. — Pl. LXIII. — Fig. 11 & 12. — Fig. 12. — Fig. 10. — Fig. 13. — Fig. 2 & 4. and Plate LVI. Fig. 2. — Plate LX. Fig. 1.

Italian Architecture.

consequently shallower. This derangement must of course increase with every succeeding ordinance, rendering it indeed impossible to make such a composition consistent. The most approved practice in arranging order above order appears to be, that the upper column shall take for its diameter the superior diameter of the one below it; that when the columns are detached their axes shall be in the same perpendicular line; but when attached or engaged, the plinth of the pedestal of the upper shall impend the top of the shaft of the lower column. The most rational mode, however, for diminishing, if reason can be applied to such compositions, is to carry the diminution through, the outlines of the columns of the lowest order being drawn up in the same direction, and so the columns of every story would take up their place and be diminished in regular gradation. When columns are attached, or pilasters used, in Italian architecture, the almost invariable custom is to break the entablature over every column or pilaster, or over every two when they are in couples. Because of the great length of the intercolumniation, it would appear to have been done at first; but it has frequently been done by some of the most esteemed practitioners of the school, even without that excuse, so that it may be held as approved by them. A basement is either a low stereobate or a lofty story, as it may be intended to support a single ordinance the whole height of the main body of the structure, or indeed the lowest of two or more orders; or as it may occupy the ground story of a building, and support an ordinance, or the appearance of one, above. In either case, much is necessarily left to the discretion of the architect; but in the latter the height of the order it is to support is the generally prescribed height of the basement. A basement may be rusticated or plain; if it be low, and is not arranged like a continued pedestal, it must have neither cornice nor blocking course; but if lofty, a deep, bold, blocking course is indispensable. An attic may vary in height from one quarter to one third the height of the order it surmounts; attics are arranged with a base, dado, and coping cornice, like pedestals, and generally have pilasters broken over the columns below. The rule for the form, composition, and application of pediments in Italian architecture, if it may be gathered from the practice of the school, appears to be to set good taste at defiance in them all. We find pediments of every shape, composed of cornices, busts, scrolls, festoons, and what not, and applied in every situation, and even one within another, to the number of three or four, and each of these of different form and various composition. The proportion laid down for the height of a pediment is from one fourth to one fifth the length of its base, or the cornice on which it is to rest. Balustrades are used in various situations, but their most common application is in attics or as parapets, on the summits of buildings, before windows, in otherwise close continued stereobates, to flank flights of steps, to front terraces, or flank bridges. Their shapes and proportions are even more diversified than their application: that of most frequent use is shaped like an Italian Doric column, compressed to a dwarfish stature, and consequently swollen in the shaft to an inordinate bulk in the lower part, and having its capital, to the hypotrachelium, reversed to form a base to receive its grotesque form. The base and coping cornice of a balustrade are those of an ordinary attic, or of a pedestal whose dado may be pierced into balusters. The general external proportions of an edifice, when they are not determined by single columnar ordinances, appear to be unsettled. The grand front of the Farnese Palace in Rome is in two squares, its length being twice its height; the length of each front of Vignola's celebrated pentagonal palace of Caprarola is twice and a quarter its height above the bastions. In Palladio's works we find the proportions of fronts to vary so considerably, as to make it evident that he did not consider himself bound by any rule on that point. In some cases we find the length to be once and one sixth the height, in others once and a fourth, once and a half, twice, twice and a sixth, and even thrice and a sixth; and elevations by other masters of the school are found to vary to the same extent. The proportions of rooms, again, range from one to two cubes inclusive, though it is preferred that the height should be a sixth, or even a fifth less than a side when the plan is a square; but the sesquialteral form, with the height equal to the breadth, and the length one half more, is considered the most perfect proportion for a room. There is considerable variety and beauty in the foliate and other enrichments of an architectural character in many structures in Italy, but very little ornament enters into the columnar composition of Italian architecture. Friezes, instead of being sculptured, are swollen; the shafts of columns, it has been already remarked, are very seldom fluted, and their capitals are generally poor in the extreme; mouldings are indeed sometimes carved, but not often; rustic masonry, ill-formed festoons, and gouty balustrades, for the most part supply the place of chaste and classic enrichments. This refers more particularly to the more *classic* works of the school; in many of the earlier structures of Italy, especially those of the Trecento period, and on monuments of various kinds, we find what may be called a graceful profusion of ornament, of the most tasteful and elegant kind; few carved mouldings, however, and very few well-profiled cornices, are to be met with in Italian compositions of any kind. In many of the later architectural works of that country we find again a profusion of ornament of the most tasteless and inelegant description, chiefly in the gross and vulgar style, which is distinguished as that of Louis XIV. of France.

Pl. LXVI. Fig. 2.

Pl. LXV.

Pl. LXVI. Fig. 1.

Pointed Architecture.

Of Pointed Architecture.

There are so many varieties of this beautiful style, and the variations are at the same time so considerable and so minute, that it is impossible to describe it generally. Every country in which it was practised had some peculiarities in its composition, and, to develope it perfectly, all of them should be pointed out. This, however, would far exceed our limits; and as the specimens of our own are not excelled, if indeed they are equalled, by those of any other country, a consideration of the style as exhibited by them will afford us a better opportunity of developing it than could be obtained by making our observations more general.

Various classifications of Pointed architecture have been made, and in almost all of them the arch is considered the index, as the column is in columnar architecture; for, like that, it is more expressive of variety than any other feature in the composition to which each belongs. These, too, form the grand distinctions between the Greek and its derivative styles, and the Pointed; but, independently of the column in the one and the arch in the other, the two species of architecture may be said each to have certain governing principles, which sufficiently distinguish and make it impossible to mould them together in one composition, and almost to apply any of the leading forms of the one to the other. They may be thus generally laid down. In Greek and Roman architecture the general running lines are horizontal, as in entablatures and single cornices. In Pointed, the general running lines are vertical. In the former, arches are not necessary to a composition; in the latter, arches are a really fundamental principle. In Greek and Roman, again, columns require an entablature; in the Pointed style no such thing as an entablature composed of parts is appli-

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cable to the pillars, columns, or shafts. (*Vide* Rickman's *Attempt*, &c. p. 110.)

These, however, only determine the generic differences which exist; the varieties in the former styles we have found to be marked by such and such distinctive features in the columns and their accessories, which allowed them to be divided into orders. In the latter the varieties arise chronologically, and, consisting for the most part in the forms and arrangements of details, are not incoherent; nor are certain proportions either fixed or determinable, and consequently they cannot be rendered into orders.

It has been customary, in treating of Pointed architecture, to class with it the Saxon and Norman Gothic styles. This is at least unnecessary, as they have no direct relation to it, except that of immediate precedence in point of time, and that the one was the stock on which the other was grafted. The peculiarities of Pointed architecture are indeed totally independent of those of its predecessor the Gothic; nevertheless we should hardly be excused for passing over the latter in total silence.

According to the best authorities, there are very few specimens of architecture now in existence in this country which can properly be called Saxon, that is, of a date anterior to the Conquest, and not of Roman origin; and those few are of the rudest and most inferior description. Saxon, therefore, as far as the architecture of this country is concerned, is an improper term. All the ancient structures which are distinguished by the semicircular
Pl. LXVII. arch may be called Anglo or Anglo-Norman Gothic. It
Fig. 1, 2, consists principally of massive columnar piers supporting
3, 4, 5, 6. semicircular arches, similarly arched doors and windows,
7, 8, & 9. and arches on small columns in relief, against a dead wall, to ornament it. The pier when round has a rudely foliated or a rounded capital, and generally a moulded base, and is variously ornamented on the surface, being altogether a rude resemblance of the columns of Roman architecture: it is at times polygonal, and sometimes piers consist of clusters of small round shafts. Frequently in doors and windows thin columns with rude capitals and bases receive the mouldings of the arched head; and, when the opening is divided, such columns are placed like mullions, to support the inner arches. There are examples of this style which are quite plain in every particular; but it is generally enriched by deep congeries of mouldings on the arches, which, when there are no columns, run down the jams of doors. These are again frequently carved, and mostly with the zigzag or chevron ornament: grotesque masks, and rude representations of animals, foliage, and flowers, form also common enrichments in Anglo-Gothic architecture.

This style prevailed down to the reign of Henry II. of England, when the pointed arch made its appearance. A degree of impressive grandeur pervades its productions, notwithstanding their clumsiness, arising from the great simplicity of manner and massiveness of proportion by which it is distinguished. The best existing specimens in London are the vestibule of the Inner Temple church, which, moreover, exemplifies the transition; many parts of the church of St Bartholomew in Smithfield, and the chapel of the Tower of London. Exemplifications of the style are also to be found in the interiors of Norwich, Chichester, Gloucester, Canterbury, Worcester, Rochester, Winchester, Durham, Peterborough, Oxford, and Hereford Cathedrals. According to Mr Rickman, the naves of Peterborough and Rochester are the most unmixed specimens. Parts, which are easily distinguished, of the exteriors of many of the same edifices, portions of Lincoln, and the towers of Exeter Cathedrals, Bigod's Tower at Norwich, and the White Tower in the Tower of London, afford characteristic external examples of the Anglo-Gothic style. The most striking castellated remains are those of Rochester in Kent, Hedingham in Essex, Consibrough in Yorkshire, and Guildford in Surrey. Many minor edifices, principally ecclesiastical, exist in almost every county in England. Mr Rickman remarks two specimens of this style as peculiarly deserving of attention; the one in the vestibule or entrance of the chapter-house at Bristol, and the other in the staircase leading to the registry of Canterbury Cathedral; the former for its simplicity and beauty of composition, and the latter for its singularity, and as exhibiting a very fine specimen of enrichment. The roofs, or ceilings rather, of the Anglo-Gothic edifices, were mostly of wood; but there are various examples of stone-groined ceilings to be found in crypts, which appertain to this style. Spires were unknown: there are, however, turrets crowned with large pinnacles of a date anterior to the introduction of the pointed arch, as in Rochester Cathedral, and the Church of St Peter in the East at Oxford. Towers were not uncommon; they are square massive structures, rising to no great height above the roof of the buildings to which they are attached. It may be remarked in addition, that many of our ancient structures retain the circular-headed or Anglo-Gothic door, when all the rest has been removed, and replaced by work of a later date.

Architects and antiquaries have generally agreed in dividing Pointed architecture into three styles of three succeeding periods. The first commences with the establishment of the pointed arch, and the formation of the style or manner which accompanies it, in the latter part of the twelfth century, the time of Henry II. of England; the second arose in the beginning of the fourteenth century, in the latter part of the reign of Edward I., and was itself superseded before that century closed, about the time of Richard II., by the third style, which is the latest, for with it, on the introduction of the *Cinque-cento*, Pointed architecture ceased to exist. A difficulty arises in appropriately naming these three styles, for on that point there is no degree of accordance among those who are best qualified to be considered as authorities. Mr Rickman calls the first the "Early English" style, the second the "Decorated English," and the third the "Perpendicular English;" to all of which terms Mr Britton objects, and, without giving appellations, except to the first, which he calls the "Lancet Order of Pointed Architecture," suggests that the second might be named with propriety the "Triangular Arched," and the third the "Obtuse Arched." Objecting strongly to the term "Order," used by Mr Britton, we think with him that the first might be appropriately called the "Lancet Arch" style; but his other distinctions are certainly not more defensible than Mr Rickman's. In the absence, therefore, of unobjectionable distinctive terms, as the varieties arise chronologically, we will speak of them as Periods.

Of the First Period of Pointed Architecture.

Mr Rickman describes this style as being distinguished Plate
by pointed arches, and long narrow windows without LXVIII.
mullions, and a peculiar ornament, which, from its resem- Fig. 1.
blance to the teeth of a shark, he calls the toothed ornament. There is very considerable variety in the forms and proportions of its different examples, as they retain the massive character of the Anglo-Gothic, or tend to the more florid style of the next period. In the former the Pl. LXVII.
sharp lancet arch is found at times, in a series of its nar- Fig. 12.
row windows, with rude piers between them, occupying the place of the precedent large circular-headed opening; Fig. 11 &
and in other places springing from the round columnar piers 13.
of the former period. In its more advanced works we Plate
find the same long narrow window systematically arranged, LXVIII.
singly or triply, with light clustered columns, against the Fig. 1.

Pointed Architecture.

piers which divide them, receiving the deep congeries of mouldings which forms the archivolt. Its columned pier, too, consists of clustered shafts, generally on a round core, and always forming cylindrical masses, girded at different heights with slight rings or belts of mouldings. Their capitals consist for the most part of congeries of mouldings following the form of the shafts, though rich and flowering capitals are not uncommon. Moulded bases, too, are generally used, not dissimilar in form to what is called the attic base of Italian architecture.

Pl. LXVII. Fig. 14. Plate LXIX. Fig. 1.

The lancet arch is described from two centres about an acute-angled isosceles triangle in the line of its base, with a radius equal to twice and one third (in some cases more, and in some less) the length of that base, or of the span the arch is to embrace. This, though the ordinary, is not, however, the universal form of the arch in the first period; but the absence of mullions, and in general of tracery, may almost be considered a criterion: yet foliations or featherings are not uncommon, especially in doors, and as enrichments to flat surfaces, though every thing of the kind certainly indicates an approach to the style of the succeeding period. Ribs on the angles formed by the intersections of arches in groined ceilings, not in ramified tracery, but with bosses at their apices alone, appertain to works of the first period. These ribs sometimes spring from corbels, and sometimes from the heads of slight shafts, which may run uninterruptedly from the floor to the springing of the arched ceiling, against the walls or against the columnar piers; and a small cornice or tablet continuing round them, runs along horizontally to separate the vertical from the vaulted surface. Buttresses in general, of various forms, sometimes in diminishing stages and sometimes upright, with acutely gabled heads without crockets, but having finials—and flying buttresses in particular—belong to this style. The tablets or cornices, mouldings, ornaments, and the variety and arrangement of niches, must be gathered from examples. The parapet or battlement is straight and uninterrupted, and is either plain or ornamented with series of arches or panels with foliations. Turrets are in some cases square, in others octagonal; but the pinnacles which surmount them are almost always of the latter form, and plain or crocketed, as the work may be more or less ornate. Towers, in the style of this period, were generally made to receive that beautiful characteristic of Pointed architecture, the spire. This, in the best examples, is octagonal in its plan, and of pyramidal elevation, running to a point, or nearly so, under an angle of about 12°, the angle at the base being consequently 84°. In some cases the spire is richly crocketed like the pinnacles; but whether plain or crocketed, it is surmounted by a bold finial.

Plate LXVIII. Fig. 1.

The most perfect structure in this style throughout is Salisbury Cathedral, which, unlike any other Pointed cathedral in England, except perhaps that of Bath, was begun and finished in the same manner; and so excellent an example is it, that it has been proposed to call the style of the period the Salisbury style. Not inferior in merit, and hardly less perfect a model of the same, is Beverley Minster. That which is of later date in it is easily distinguishable; and being confined to particular parts, it hardly interferes with the unity of the composition. The transepts of York Minster are also of the first period, and so is a great part of Westminster Abbey. The fronts of Ely, Lincoln, and Peterborough Cathedrals exhibit good specimens of it. Indeed there is hardly one of all our Pointed cathedrals which does not partake of this style in a greater or less degree. It will be most generally found interwoven with and superimposing the Anglo-Gothic where that exists, and inferior to, when in connection with, works of a later period. Many of the monastic structures with which the country abounds present very beautiful specimens of this style also. Among other excellent examples of it may be particularized the chapter-houses of Lincoln and Lichfield. Those beautiful monuments which the affection of Edward I. induced him to raise to the memory of his wife, called the Crosses of Queen Eleanor, are in the style of the first period, though they verge on that of the second, and indeed mark the transition which took place in the latter part of that king's reign.

Of the Second Period of Pointed Architecture.

The style of this period, which is thought by many to be the classic age of Pointed Architecture, is described by Mr Rickman as being distinguished " by its large windows, which have pointed arches divided by mullions, and the tracery in flowing lines forming circles, arches, and other figures, not running perpendicularly; its ornaments numerous and very delicately carved." Mr Britton says that " during this period the Pointed style received its greatest improvements;" and that, limiting it to the time of Edward III., " the form of the arch then principally in vogue admitted of an equilateral triangle being precisely inscribed between the crowning point of the arch and its points of springing at the imposts." The mullions of this style clearly result from the slender shafts which were used in that of the first period against the piers dividing a number of windows. The piers being removed, it became necessary that an arch should be turned from side to side, leaving a space to be filled up in the head above the smaller arches. This was done by repeating and continuing their contours, and connecting them by gracefully flowing lines and foliations. It is indeed but an extension of the former; for in some of the early examples the mullions are thin columnar shafts having capitals and bases, and the head of the arch is generally filled up with regular figures, such as foliated circles, leaving spandrels or triangular circular-sided spaces in various parts. It is in the more advanced works of this period that the tracery becomes what may be truly called flowing. The mullion is angular and moulded, and the mouldings run all through the composition; the jamb or architrave mouldings also run through, and for the most part without the intervention of any horizontal mouldings at the impost or springing of the arch. Besides the ordinary covering cornice or drip-stone following the form of the arch, we find a moulded cornice, generally arranged pediment-wise, embracing a window or door, having crockets and finials, and resting on corbels, which are almost always masks. This may be called an attached canopy. The columnar piers of this period are nearly square in plan, and are placed diagonally. They are sometimes composed of clustered shafts, and sometimes of shafts separated by deep hollows. Their capitals are either moulded simply in rather a deep congeries, or with woven foliage under a moulded abacus. Their bases are a diminishing series of bold mouldings, supported generally by a vertical-faced octagonal plinth. The shafts which support the ribs of the roof or ceiling tracery, in the finest examples of this style, spring from rich and bold corbels in the angles of the arches, or the spandrels, immediately above the piers. The groining ribs do not adhere to the angles of the groins merely, but are set more profusely to form tracery; and rich bosses are put at every intersection. Buttresses of the second period are exceedingly various: on quoins they are mostly set diagonally. They either diminish gradually in heights or stories, and finish under the cornice, or they run through and are surmounted by pinnacles. In some cases the sets-off in diminishing are made simply with an inclined shelf; in others every set-off is formed with a pediment properly

Plate LXVIII. Fig. 2 & 3

Fig. 4 & 5, and Plate LXX. Fig. 1.

Plate LXIX Fig. 2

Plate LXX. Fig. 1.

Pointed Architecture.

enriched, and the face of the buttress is commonly ornamented with blank tracery in panels or in niches. Flying buttresses of this period are also more ornate than those of the preceding; indeed in this they became ornaments, whereas in the former they appear to have been kept out of sight as much as possible. Parapets are either pierced or embattled, and a similar variety is maintained in pediments. Pinnacles are generally square, but they stand diagonally with regard to the turret or buttress on which they are placed, their angles resting on the apices of the pediments which surmount the faces of the substructure. These pinnacles are richly ornamented with crockets and finials. Spires are less common in the more extensive works of this period than in the precedent; but in those of minor importance they are frequent, differing little, however, from the same object in works of the first period, except in being more highly enriched. Towers are richly pinnacled; but the pinnacles rest for the most part on small turrets rising from the angles of the tower itself, and seldom from projecting turrets or from the heads of buttresses, which latter are generally found to die away below the cornice. The details and enrichments of this style are too curious and complicated for verbal description, but they may be gathered from the examples.

We possess no one complete cathedral of the second period, but almost all our larger Pointed structures present specimens of it in a greater or less degree. Excepting perhaps the upper story or belfries of the towers of York Minster, which are of the third period, its west front is a model for this style, and it presents specimens of almost all its external peculiarities. The nave of the same edifice, and the interior of Exeter Cathedral, are perhaps the finest examples of the second period. The latter edifice, indeed, has the reputation of presenting a greater and more pleasing variety of tracery than any other of the same style. To these may be added the cathedrals of Lincoln and Ely, both of which contain much that is valuable. Next to these cathedrals may be placed Beverley Minster, which is not only a mine of beauty of the first, but it presents many exquisite specimens of this period also. The steeple of St Mary's Church, Oxford, is a fine example in this style of the combination of tower and spire. Many minor works in England, and several in Scotland, are excellent; particularly much of what remains of the High Church, Edinburgh, much of the remains of Elgin Cathedral, and the largest portion of those of Melrose Abbey, which, it would appear, was not excelled, when perfect, by any thing in the kingdom.

Plate LXX. Fig. 1.

Of the Third Period of Pointed Architecture.

This is that period of the style commonly known as florid Gothic. The first authority quoted with regard to the styles of the two preceding periods calls it the Perpendicular English, and says that this name clearly designates it; "for the mullions of the windows and the ornamental panellings run in perpendicular lines, and form a complete distinction from the last style." Mr Britton, however, insists that the term *perpendicular*, though perhaps proper enough, if the style could be sufficiently distinguished by the mullions of the windows and the upright forms and continuity of the panelling over entire surfaces, "gives no idea of the increased expansion of the windows, nor of the gorgeous fan-like tracery of the vaultings, nor of the heraldic description of the enrichments which peculiarly distinguished this period; neither does it convey any information of the horizontal lines of the door-ways, nor of the embattled transoms of the windows, nor of the vast pendents that constitute such important features in the third division." Although windows with tracery in them may be determined as belonging to this period, by the perpendicular and parallel lines found in the head or arch, and by the use of transoms to divide the bays into heights, yet the presence of a window of this kind does nothing towards fixing the style of the edifice generally to which it may belong; for in hundreds of cases this sort of window will be found where it is the only specimen of its age or style in the structure. Other points must therefore be attended to.

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Plate LXVIII. Fig. 6.

The simpler arches of this style are, like those of the preceding periods, struck from two centres only; the two sides or halves of the arch are similar segments of a circle whose radius in this case is about three fourths the width of the opening. Others are segments of ellipses, and are of course struck from four centres; but some are eccentric curves, which may be drawn, but cannot be described. Many of both the latter descriptions are extremely flat or depressed, the angle at their apex being very obtuse. The ogee or contrasted arch is also found in works of this period, but this is more common in internal tracery than in external form. The modes of arranging tracery must be gathered from examples, for they possess no degree of regularity to render it possible to describe them generally in words. Mullions are richly moulded, and so are the architraves of both doors and windows; the deep congeries of mouldings forming architraves are not intercepted by horizontal or impost mouldings, but run through from the head down the sides or jambs. The angular or pedimented canopy to an arched opening in the style of the second period assumes in this the form of a contrasted arch; it is corbelled and enriched with crockets and finials as in that. Doors, however, in this style are peculiar, because whatever the form of the arched head may be, it is inscribed in a square frame or canopy, the spandrels being variously enriched. Columnar piers of this period are of almost parallelogramic form, thinner in the direction of the arches, and generally plain on the longer sides, but deeply moulded and running to a thin shaft on the outer edges. These mouldings are those which enrich the arch, there being no capital of any kind to intercept them, so that they run, as in windows and doors, all round the opening. To this, however, there are exceptions. The thin shaft which is formed on the outer edge of the pier continues through from floor to ceiling, to receive the groining ribs; and it has a thin congeries of mouldings at either end to form base and capital. The tracery of the ribs of groined ceilings of this period is most profuse, and beyond description intricate. To this also belongs the absurdity called basket groining, in which the arches are made to spring on one of their sides from a pendent mass, which, though rich and gorgeous in appearance, threatens constant ruin. Quoin buttresses standing diagonally are not so common in this as in the preceding style: in form, however, they are not dissimilar, excepting that the sets-off are plain moulded slopes for the most part, instead of having pedimented or triangular vertical heads, as in that. Flying buttresses are, like the style generally, very much enriched, and are very commonly used. Parapets are variously arranged; indeed they embrace almost every peculiarity, being either plain, panelled, pierced, or embattled; each decorated arrangement is effected by different means. Pinnacles in this style are generally square, but there are examples of pinnacles which have a greater number than four sides; in the former and most usual case they are sometimes placed with their sides parallel to those of their pedestals, and sometimes diagonally: they are of course in every case highly enriched with crockets and finials. Spires of this are hardly distinguishable from spires of the preceding period; and towers, of which there are innumerable specimens, may be known by the construction of their buttresses, and by the arrangement of the tracery in the heads

Plate LXXI. Fig. 1.

Fig. 8 & 11.

Plate LXX. Fig. 1.

Windows of towers Plate LXXI. Fig. 1.

Fig. 4.

Fig. 8 & 11.

Fig. 1.

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of their windows, as the windows of towers are generally contemporaneous with that story, or stage of it at least, to which they belong. Octagonal or otherwise polygonal turrets at the angles of buildings are not uncommon, and they generally finish with an embattled parapet. The pedestals which support the pinnacles on the angles of towers, and at the heads of buttresses, seldom have pedimented faces, as in the preceding period, but finish with a corbelled battlement, and not unfrequently send up minor turrets and pinnacles from its angles.

In the more ornate works of this style the enrichment of flat surfaces is carried to great excess, and it is generally effected by means of panelling. Niches with their canopies, tabernacles, screens, and stalls, exhibit the most exuberant profusion of ornament, for the most part effected in this manner; but we find, besides, a considerable variety of ornaments, foliate and heraldic; of the former the Tudor flower, which is a combination of the roses, is pleasingly predominant.

The only one of the cathedrals entirely of this period is that of Bath; but being generally inferior in merit to many other examples, it need not be cited. Many of the cathedrals, however, have large portions in this style, which can hardly be mistaken if the form of the arches, the arrangement of the tracery, and the mode of enrichment, be attended to. The finest west fronts of the third period to cathedrals are those of Gloucester, Winchester, and Chester; but that of Beverley Minster is by far the most perfect and most classic specimen in existence, not excepting the front of Westminster Hall, which is also of great merit, and presents a classic exemplification of most of the peculiarities of the style. Taken as separate edifices, the chapels of St George at Windsor, of Henry VII. at Westminster, and of King's College at Cambridge, are the most complete, as they are entirely and peculiarly of the third period. The central towers of the archiepiscopal fanes of Canterbury and York, the tower of Gloucester Cathedral, that of Magdalene College, Oxford, Boston Tower, and the tower of St Mary Magdalene at Taunton, are singularly excellent examples of the style. To smaller edifices, those of Wrexham and Gresford in Wales, and of St Neot's in Huntingdonshire, are particularly beautiful. Of steeples, that is, towers having spires superimposed, there are many fine specimens; but the most perfect, perhaps, in composition are those of Bloxham in Oxfordshire, and Louth in Lincolnshire: the former is most admirable rather in general than in detail. Many of the monastic ruins throughout the country present excellent specimens of this style also; indeed it is to ecclesiastical structures we must look for architectural display in Pointed architecture, as in that of the Egyptians, Greeks, and Romans. We have just specimens enough existing of the architecture of the secular structures of our ancestors to show how inferior it was in merit to that of the ecclesiastical; and if the castellated mansions of the nobility, and the palaces of the sovereigns, cannot vie in excellence with the cloistered cells of the monks, we may be well assured that ordinary domestic architecture was still more of an inferior cast.

Plate LXXI. Fig. 1.

Elements of Beauty in Architecture.

Simplicity and harmony are the elements of beauty in architecture; simplicity in the general form and arrangement of a subject, and harmony in the collocation and combination of its various parts. Without these qualities a structure can never possess either dignity or grace, and with them it will certainly possess the attractions of both. The outline, then, most conducive to beauty in architecture, is that which bounds the most simple forms. These are the parallelogramic and pyramidal, in which the lines are straight and uninterrupted throughout their whole length. The ancient monuments of Egypt, of Greece, and of Rome, offer the most complete exemplifications of this. No other than the long, unbroken line which bounds the temples of Egypt could produce an effect so grand; and no other than the simple, square, and pyramidal forms, could be productive of so much dignity as they possess. In the pyramids and obelisks of the same country the effect of this simplicity is even more obvious. In the temples of Greece, again, the same dignified simplicity is still predominant; for although in them the parallelogram and pyramid are combined, they are not confused; their mass consisting of a parallelopipedon whose ends are surmounted by vertically faced pyramids, connected by an unbroken line of ridge running parallel to the horizontal boundaries of the sides. Those of the Roman monuments which are deficient in simplicity are also deficient in beauty. Such are the triumphal arches, whose general form is broken by columns and arches which subject themselves to no commanding outline, but are all at the same time prominent features of and excrescences from the general composition. In the temples which are on the Greek model it is not so; nor is it so in the long series of arches in the Roman aqueducts, which are crowned and connected by commanding lines, unimpeded by projections or protuberances of any kind. The crucial form of the Pointed cathedral may be thought to detract somewhat from its simplicity, and so much from its beauty; but it is an aggregation of simple forms, perfectly coherent with the tendency of the leading lines in the style, which, we have seen, is vertical; and the lines are therefore not broken by the projected masses of the transepts, as they would be in the Egyptian and other styles, the tendency of whose commanding lines is horizontal. Otherwise the Pointed cathedral is a modification merely of the form of a Greek temple, with other parallelogramic forms added to it, as towers, or pyramidal, as spires. The same principle will be found to pervade the best works of the Italian school, more or less modified according to its application.

Beauty in Architecture.

Pl. LII.

Pl. L.

Pl. LX. Fig. 10 & 11.

Next to the straight line is the circular; but the greater complexity of this latter, and the variety of which it is capable, render it more subtile, and for the most part less competent to produce grand and impressive effects, except under peculiar circumstances of situation and combination. A cupola such as the cupolas of St Peter's at Rome and St Paul's in London, if placed on its base on the ground, or even on a low structure, like a large beehive, would be not merely ineffective, but absolutely ugly; and if, in the situations they occupy, the cupolas referred to were without the diminishing pinnacles above them, to bring their general outlines within that of the pyramid, it is a question whether they would possess the attractive beauty they now do. If St Paul's be looked at in the gray twilight of morning or evening, or when a mist renders its form indistinct, the impression conveyed by the mass is that of a lofty pyramid or cone, rising out of the substruction which the cathedral forms, and running off to a point in the sky. The superstructure of St Peter's is, as we have seen, more depressed, and less perfectly formed in this particular; yet nevertheless it may be submitted to the same test, and the same or nearly the same result will follow. Furthermore, let a hemisphere or an oblate hemispheroid be supposed in the place of the prolate hemispheroid, as at present, and this reasoning will be rendered more clear; for neither of those forms, even with the accessories these possess, would be as beautiful; and without them they would be ungainly deformities, as is proved by that example on the new palace in London, on the site of Buckingham House.

Pl. LXV.

Beauty in Architecture.

The cupola of University College, London, exemplifies this point also; for though its profile is elegant, and its accessories are generally good, the composition does not resolve itself into a simple form, and the result is far from being beautiful.

When the circular form is employed cylindrically, the utmost simplicity is required to be preserved in its horizontal, as well as in its vertical lines, or the result will be totally devoid of all architectural beauty. In proof of this, let the broken and dentilled columnar ordinance which surrounds the tholobate of St Peter's be compared with the noble, unbroken peristyle in the corresponding part of St Paul's. In the former the cylindrical mass is studded with a series of minute excrescences of coupled columns; and in the latter it forms a grand, beautiful, and effective compartment of the composition.

The preceding remarks do not of course apply to the interior of a structure in the same manner; for although as high a degree of simplicity is required internally as externally, similar combinations are not necessary, nor are they indeed always available. A spacious concave, of whatever form its profile may be, so that its plan be a perfect circle, is one of the grandest works of architecture, and at the same time one of the most simple, whether it occupy a compartment of the structure to which it belongs, as in St Peter's and St Paul's, or cover the complete edifice to
Pl. LX. Fig. 4. which it appertains, as in the Pantheon at Rome. In such situations it is indeed almost impossible to destroy its inherent simplicity; and being unconnected with external circumstances, it requires no coherence with any thing else, being as independent of its substructure as of its external contour for effect. Irregular and intricate forms, however, in works of architecture, whether internally or
Figs. 1 and 2. externally, will be found unpleasing. Few can admire the external effect of the Pantheon, or of the structure in London called the Colosseum, which has been subjected to the same arrangement, though certain features in both may be indisputably good. To these may be added the church in Langham Place, London, and indeed many others; but that is an egregious example in point. The complication of straight and circular in their composition, and the consequent irregular forms and undefined outlines, totally destroy both simplicity and harmony. The comparison of an Egyptian obelisk with a monumental column of the same relative size will afford the strongest proof of the superiority the more simple form possesses over the more complicate. None, however, but those who have visited Rome, in which city alone the comparison can properly be made, can duly appreciate this evidence; but London furnishes a contrast almost as much to the purpose, in the monument on Fish Street Hill, and the lofty shot tower by the south-west abutment of Waterloo Bridge. They are both of nearly cylindrical form; but the one is crowned by a square abacus, and the other by a bold cornice, which follows its own outline. The greater simplicity and consequent beauty of the latter, having regard to general form alone, are strikingly obvious.

Not only in general form and outline is simplicity necessary to beauty in architecture, but also in all its details, and even in its enrichments. In exemplification of this, a plain Greek entablature may be compared with one in the Roman style, in which every thing is sacrificed to profuse ornament; and the style of ornament in the latter may again with equal advantage be compared with that of the age of Louis XIV. of France. In the arrangement of the parts of a composition, as well as in the composition itself, simplicity is essentially necessary to the beauty of the whole; every style will afford exemplifications of
Pl. LV. Fig. 5. this also, in the comparison of the more simple with the more complicate specimens of the same. Compare the few simple and well-defined parts of a Grecian Ionic entablature with a Roman or Italian example of that order in the latter will be found a complexity and straining at effect not at all consistent with beauty and dignity, determining the comparison much in favour of the former; Pl. LIX. Ex. 3.
and so in many other cases which might be cited. That Pl. LXII. Fig. 4.
the more simple arrangement of columns at equal distances is superior to that in which they are coupled or placed only alternately equidistant, is clear from the fact that the latter mode was first proposed, and is only used to obviate difficulties, and not from choice, except in the works of the merest pretenders.

Harmony, concord, or fitness—of proportion, of form, of one part of a composition to another, and in the collocation of the various enrichments which architecture requires,—is as necessary to its beauty as simplicity. We do not speak of the agreement which should exist between the manner or character of a structure and its application, for that is purely conventional, and totally independent of any architectural consideration. The merit or demerit of a composition is not at all affected by the use to which the edifice is applied; neither would its front be more tolerable, nor its cupola less beautiful, if St Peter's in Rome were, by the course of events, to become a democratic forum instead of a papal basilica; nor is the monument of London a more or less elegant object, whether it be understood to record a triumph or a defeat—the burning of the city, or its re-edification. Harmony in architecture is that agreement which exists between its various parts, as in the relation of a column to its entablature and stylobate, in the accordance of a cornice with the elevation it crowns, and in the coherence of one part of a composition with another. It is that which exists in the common tendency of the leading lines of a structure; and it is that which blends the straight and circular in enrichment or decoration, as in the capital of an Ionic column whose square and horizontal form is harmoniously adapted to the vertical lines and cylindrical form of the shaft, by the intervention of the volutes. An inharmonious combination arises out of the collocation of the same voluted capital with a pilaster or squared pier. This quality requires a judicious arrangement of ornament. That a certain degree of enrichment should pervade the whole of a composition, and not be confined to one part of it—for instance a Corinthian ordinance, in which the columns are unfluted and the entablature is quite plain—is inharmonious; for the capitals being masses of rich foliage, are spots, having nothing to connect them with the rest. A degree of harmony must exist, too, between the solids and vacuities of an edifice. An Italian portico, with its thin and straggling columns, is an inharmonious object, for it conveys an idea of infirmity and poverty, which is not the case with one proportioned like the best Greek and Roman examples. In the front of a house, windows and the piers between them being too wide or too narrow will affect its character in this respect. The comparative size of various portions of the same composition, though they be in themselves simple and harmonious, may be such that they shall not be so in combination. The portico of University College, London, is of great extent and considerable beauty, and the cupola behind and above it is of elegant form, though deficient in another particular, as we have already stated; yet they do not harmonize—the one is much too large for the other, and their forms are incoherent.

Thus harmony has reference to comparative magnitude, strength, decoration, disposition, and proportion. To acquire a knowledge of all these sufficient to produce a worthy result, a long course of study and careful observation are necessary: but such can only be necessary to the architect; it is enough for the general student to be

able to appreciate them when present, and to detect their absence.

Principles of Architectural Composition.

These must be different in the widely differing species of architecture, whose tendencies in the one are to horizontal or depressed, and in the other to vertical or upright lines and forms; the former including all those varieties which proceed from the Greek and Roman modes of design, or columnar and circular-arched architecture; and the latter embracing those which arise out of the pointed arch, and which we have distinguished by the term Pointed. Except in the elements of architectural beauty, which must be the same in all architectural works, there is no similarity whatever between the principles which govern composition in the two species. Simplicity of form, and harmony between the parts, are as essentially necessary to the one as to the other; but instead of the leading horizontal lines required by the former, the latter is distinguished by the absence of commanding lines having that tendency, and by the presence of strongly marked lateral projections and vertically inclined lines. The rectangular figure formed by the front of a Greek temple, below the pediment, rests on one of its longer sides as a base. In a Pointed composition that order is reversed, and one of the shorter sides becomes the base; and the pediment, instead of being a depressed obtuse-angled triangle, becomes upright and acute-angled; the whole mass, moreover, follows the change thus described, so that the same figure, a parallelopiped, is set for horizontal or vertical composition, as a larger or smaller side is made the base. This being the case, it will be necessary to treat of them separately; for rules which apply to the one are totally inapplicable to the other, and the former, being of most common application, may be taken first. We shall quote the principles which appear to have actuated the Greek and Roman architects in the production of their best works, or rather the principles which those works develope, instead of citing all existing ancient works as authorities; and determine on those principles how to produce similar results in cases of which examples do not appear in ancient practice. In the same manner, we must deduce the principles for general composition in the Pointed style, from those which appear to enter into its best existing works.

Of Horizontal Composition.

Every thing tending to break the continuity of the leading horizontal lines in a composition should be avoided. The advantage of adhering to this, and the disadvantage resulting from the breach of it, are clearly exemplified in the front of the Farnese Palace, and in the flank of St Peter's at Rome. In London, too, the fronts of the Banqueting House at Whitehall, and of Somerset House to the Strand, offer similar exemplifications of the principle; the former having both the entablatures and the stylobate of the upper ordinance broken round every column, which makes the ordinances mere excrescences, and the latter preserving the leading lines continuous and unbroken throughout, to the manifest advantage of the whole composition. This applies equally to columned and arcaded ordinances, and to compositions in which neither is used; and it is as much opposed to the projection of masses to form wings and centres, whether shallow or deep, as to the breaking of an entablature or stylobate round one or two columns. Sufficient variety of light and shadow is attainable without the use of columnar ordinances at all, as the Farnese Palace evinces. But if, however, it be required to give a greater degree of importance to an elevation than can be attained in that manner, it may be produced without either attaching or insulating columns the whole extent, by means of antæ and recessed compartments with columns in them, as on either side of the gates in the north or Lothbury front of the Bank of England, and on the flanks of the churches of St Pancras and St Martin in London; but a mere pilastraded ordinance, or pilasters with an entablature and without columns, is bald, tasteless, and unmeaning, as the front of Crockford's Club-house, in London also, very clearly shows. In speaking of the Italian style, we have shown the injudiciousness of putting order above order, because of the impossibility of maintaining a rational arrangement with regard to diminution and intercolumniation. We made that, too, an objection to the elevation of the Roman Colosseum; but the practice is moreover objectionable, because of the repetition of the similar parallel lines of the entablatures, similarly projected too, which destroy the breadth a composition should possess; and because the upper and crowning cornice, if in proportion to its own ordinance, must be disproportioned to the whole elevation which takes from that member a character of grandeur or meanness, as it may or may not be fitted to its whole height. This is made very evident by the opposed fronts of the United Service and Athenæum Club-houses in London, the former of which is finished by the thin shelf-like cornice of a second order, and the latter by a crowning cornice which has some relation to the whole height of the building. In a similar manner, and for the same reason, the practice of raising lofty basements to support columnar ordinances is injudicious; and this detracts much from the merit of the front of Somerset House just referred to, by making the crowning cornice of less importance than it should be. In St Paul's this fault is partially relieved by the somewhat exaggerated size of the cornice of the upper order, and by the insertion of cut blocks, in the manner of upright modillions, under it the whole depth of the frieze. Nothing, again, should be allowed to superimpose a crowning cornice, except what may form a part of itself, as antefixæ; where, however, something is absolutely necessary, as on a bridge, a close simple parapet, as low as it may be conveniently, should be resorted to. On the principle first developed, porticoes should not be projected from the front of a building, unless they occupy the whole extent of it, as in a Greek or Roman temple, and so carry the horizontal lines unbroken to the flanks; or they should be made distinct and independent objects, to which the rest of the composition may be subservient, as in University College. A portico should moreover be considerably projected, or the surface behind it recessed, that the columns may have a background of shadow, otherwise it will be poor and inefficient. Of this the Greek temples offer a favourable exemplification; and most of our churches, and other modern edifices which have porticoes to them, prove the correctness of the principle in the breach of it. Exceptions more or less favourable certainly exist, whose superior merit is sufficient to indicate them. A pediment should never be used unless it is made to embrace the whole of the end or front to which it is attached. Numberless absurdities have arisen in Italian architecture from the injudicious application of this form; so general, indeed, is it, that the fact of a pediment existing under any circumstance in a work of that style is almost a sufficient reason for avoiding a similar use of it. Nothing is more difficult than to combine straight and circular, or otherwise bending lines, with propriety and good taste, and therefore their collocation, in general composition particularly, should be seldom attempted. It is when they harshly contrast, as in circular pediments, and in mixed compositions of columns or pilasters, with their accessories, and arches and

Pl. LXVI. Fig. 1.
Pl. LXV. Fig. 2.
Pl. LX. Fig. 1.

Composition.

their piers, that the combination is bad; but not so in the connection of the arch with its pier, so that the former be semicircular or semielliptical, and not smaller segments, in which cases they fall naturally and gracefully together. The incoherence and inelegance of contrasted straight and circular forms are very evident in the New Exchange at Paris, where two tiers of circular-headed windows are seen within a Corinthian peristyle. Circular prostyles or cyrtoprostyles should be avoided, as their horizontal lines cannot be made to harmonize perfectly with any form to which they may be attached. This however does not apply to peristyles; and both the one and the other are exemplified by the transept porticoes and columned tholobate of St Paul's. The use of coupled columns is so absurd, and they are confessedly so inelegant, that it seems almost unnecessary to denounce them. Suppose apertures, such as windows, arranged in couples throughout an elevation, with very narrow and very wide piers alternating, and both the absurdity and the inelegance become manifest: now, neither the one nor the other can be either lessened or changed by reversing the case, and putting alternately wide and narrow openings, as in coupled columnar ordinances. Columns may with propriety be put further apart when they are attached than when they are insulated, because the entablature, resting in part on the wall, is neither in fact nor in appearance made infirm by the distension, as it would be if it rested on the columns alone. All the parts of the same edifice which come into view, under any circumstances at the same time, should correspond; but insulated and attached columns of the same ordinance and in the same elevation may, under certain circumstances, without impropriety be arranged with a different intercolumniation.

An arcaded ordinance should be considered as only more massive than, and differently shaped from, a columnar, and may therefore be governed by nearly the same principles. A pier is but a differently shaped and more massive column, and the archivolt but a succedaneum for the architrave; while a bold blocking course, or a commensurate cornice and frieze, as the composition may be more or less ornate, will complete the ordinance. Under this view nothing can be more absurd than to affix columns or pilasters to the piers of an arcade to support an entablature, and certainly nothing can be more inharmonious, from the contrast which arises, as we have just remarked, between the rectangular lines of the latter, and the inscribed circular lines of the arch, as well as the incongruity necessarily attending the interspaces of the columns.

In speaking of Greek and Roman architecture, we have shown why columns should, and why antæ and pilasters should not, be fluted; and have shown also, that a certain degree of richness or plainness of surface should pervade a composition, and not be confined to particular parts of it. It will now be enough to add, that in composing, lights and shadows should not be scattered on a surface as they are on the front of the Banqueting House, by broken ordinances; nor should either be too much narrowed, as the light on the corona of a Roman cornice too frequently is, by the too great projection of the cymatium. It will be found, moreover, that shadows projected horizontally are more in coherence with the horizontal style of composition, than those which fall laterally, or from a vertically projecting object.

Columns, &c.—The proportions of the columnar orders will be best sought in the existing examples of the ancients; and those we give of them afford sufficient variety. What is deficient in one may be made up from another; and what appears superfluous in one example may be omitted, as its omission may appear beneficially to affect another. The Doric may be adopted from the Parthenon or the temple of Theseus, as the best existing models of the order. If an ungraduated stylobate be used, which should be avoided if possible, it should not exceed one diameter in height. The intercolumniation should not exceed one triglyph, as in the Greek temples, though for compositions of a generally less dignified character it may, perhaps, be extended to two. A good modern example of the Doric order, in a work of the latter description, may be seen in the small entrance portico to the University Club-house in London. The Ionic example from the Erechtheum, which we have given, may be used as a model for that order, with the same restriction with regard to the stylobate which is made to the Doric. Additional depth may with advantage be allowed to the bed-mould of the cornice, and it may be effected by the insertion of a dentilled member, which indeed some of the ancient Greek (though not Athenian) examples possess. The intercolumniation should not be less than one diameter and a half, nor should it exceed two diameters. In London this order is admirably applied in the front of an Episcopal chapel on the east side of North Audley Street; and this particular example is very correctly copied on the exterior of the church of St Pancras. The great inferiority of the Roman examples of the Doric and Ionic orders is too evident to require that what it consists in should be pointed out, and they are the models of the Italian. The Greek example of the Corinthian order might perhaps be improved by making the dentil member of the cornice a little shallower, by projecting the corona rather less, and by correcting the form of some of the mouldings of the entablature generally. If the columns be used in a prostyle or other position to insulate them, they may with advantage be made half a diameter less in height; and the intercolumniation should be made less than it appears in the original, where the columns are attached. This example has been well executed in the entrance to the Philadelpheion or Exeter Hall, in the Strand; but the pedestals and the attic are blemishes in the composition. Of the Roman examples of this order, that of the temple of Jupiter Stator is certainly the best. Its greatest fault is the too great magnitude of the cornice, of which every member, except the corona, might advantageously be restricted one tenth of its height; that which is dentilled might indeed be reduced one fifth. The projections might also be diminished in the same proportion, removing the greater diminution of one fifth in this particular from the dentilled member to the cymatium, and the ovalo under it, both of which project by far too much. The three fascias of the architrave are too unequally divided. The lowest might be made as wide as the middle one, by deducting their difference from the third or upper one. In the Tivoli example the architrave is too shallow, and so are the dentil band and corona of the cornice; and the cymatium is both too deep and too much projected. The cornice would moreover be improved by denticulating the dentil band, and by enriching the frieze with an ornament less coarse and less massive. If this example be used in a generally ornate composition, some of the mouldings of the entablature should be enriched. The parts of the entablature of the temple of Antoninus and Faustina are well proportioned to each other. The cornice of this example would be improved by giving additional height to the dentil band at the expense of the moulding above it, and by denticulating it also. The cymatium is rather too shallow, and might be widened out of the moulding under it; and both should be restricted in their projection at least one fifth. The capital of this example is poor, and its abacus is too shallow. The shaft requires fluting, and one half the depth of the upper fillet of the base might be added with advantage to the tori and scotia. The cited

Composition. Pl. LIII. & LIV. Pl. LV. Pl. LIX. Ex. 3. & 4. Pl. LVI. Fig. 3. Pl. LVIII. Ex. 11. Ex. 2. Ex. 3.

Composition.

Pl. LVIII. Ex. 4. example from the portico of the Pantheon has, like the last mentioned, the parts of its entablature well proportioned to each other. As in the Jupiter Stator example, the architrave should be more equally divided. The mouldings, too, separating the fascias, should be made less; and the superior moulding, at least of the architrave, carved, unless the frieze were enriched, and then it would not be necessary. In the cornice a fifth or sixth should be taken from every member of the bed-mould and added to the corona. In the presence of modillions, however, the dentil band is judiciously kept plain, though the moulding below it would be better if enriched. The capital of this example is as faulty as that of Antoninus and Faustina, and in the same particulars. The shaft also requires fluting, and the base might with advantage be made to spread more. The ordinance of the temple of

Pl. LIX. Ex. 1. Mars Ultor, though the most masculine, is, from its good proportions, and the bold character of its foliage, one of the most excellent of the Roman Corinthian examples. Most of the entablature being supplied from a not well authenticated source, may not be original; but that is of no consequence, if it be beautiful. The corona, like that member in most Roman entablatures, wants greater depth; and the cymatium perhaps less, and certainly less projection. In this, as in the first-mentioned Roman example, with modillions there are dentils. This is injudicious; the member would be better plain, as in the Pantheon ordinance. The architrave, which is authentic, is exceedingly well proportioned, and the column is fine in all its parts. These examples all vary in their intercolumniation, from rather less than one diameter and a half to a fraction more than two diameters, beyond which proportions, either less or more, it would not be well to go. A stylobate to the order might judiciously be adapted from the Greek; for the stilted effects produced by insulated pedestals, and even by continuous vertical stylobates, are injurious to the general appearance of a columnar composition; and the thin steps in common use detract exceedingly from its beauty under any circumstances.

There are many varieties of the foliated capital which may be used with advantage; one of the least elegant, however, is that which assumes the distinction of being called the Composite order. The example of it from the

Ex. 2. arch of Titus is one of the best, if not the best; but it will be seen, on comparison, to be strikingly inferior to the Corinthian examples, or those in which the volutes of the capital are made subservient to the foliage, instead of being distended into huge mis-shapen knobs. The entablature, too, is only an exaggerated Corinthian. If it be wished to use foliated capitals differently composed from the ordinary, it may be well to preserve the character and proportions of the entablature the same, or nearly so. Under any circumstances, however, care should be taken in composing an entablature, that it have sufficient height, and yet not be too heavy; that it be sufficiently divided, and yet not frittered; that the parts have sufficient breadth, and be not so much projected as to bury all that is below them in shadow; and that ornament be properly distributed, and in sufficient quantity, without overloading the composition with it, as in the ordinance of the arch of Titus.

If again it be wished, under any circumstances (though

Pl. LVI. Fig. 4, 5, & 6. the practice cannot be recommended), to use human figures as columns, there appears to be no reason why the entablature should be executed without a frieze, as it is in the example of the Pandroseum; and if a frieze be inserted, it should be by lessening the other parts, and not by increasing the whole, as that entablature (taking it as a model) is quite deep enough in proportion to the height of the ordinance.

Entasis in columns need not be regarded, unless they exceed eighteen or twenty feet in height; but it adds much to their beauty, and should not be neglected when they are above that magnitude. No rule can be given for its production, but it may be thus described. The shaft, instead of being the frustum of a regular cone, is the frustum of a cone whose outline is not straight, but slightly convex; so that if it were perfect, its vertical section would have the form of a very acutely pointed arch. This convexity should, however, be so slight as in the finished shaft to be hardly distinguishable. Its abuse is evident in the columns of the east front of the church of St Paul, Covent Garden, and indeed in some of the less esteemed works of the Greeks themselves. The modes of fluting in the different orders may be gathered from the examples. The flutes should be deeper or shallower, as the collocation of the ordinance may require a greater or less depth of shadow on the surface of the columns. The elliptical or nearly elliptical contour seems to be the most generally pleasing. The flutes meet in an arris on columns of the Doric order, and are separated from each other by alternating fillets in the Ionic and Corinthian.

Antæ and Pilasters.—These should seldom be used, externally at least, unless with columns, for their real use is to connect a columnar ordinance with the walls to which it is attached; and being, as they are, but slight projections from walls for that purpose, nothing can be more absurd than to give them the features of columns, either by the application to them of similar capitals and bases, by diminishing, or by fluting. The use of antæ was rightly understood by the Greeks, but not by the Romans; and their proper use may be seen in the works of the former. The examples in London of their judicious application, most worthy of remark, are in those edifices already mentioned as exhibiting good specimens of the Greek orders, in the Bank of England, and in the portico only of University College. The adaptation in these of other than the bold foliage and branching cauliculi of the columnar capitals in the Corinthian ordinances to the antæ caps is particularly worthy of notice (though they are not all of equal merit as compositions), as the Greek remains are without a regular example of Corinthian antæ, and the Roman practice is inelegant.

Pediments.—As there is no mode by which the pitch of a pediment can be determined, it must be left to the taste of the designer to be governed or not by the examples of Greek and Roman antiquity: it may, however, be premised of them generally, that those of the former school are too flat, and those of the latter too steep. The pediment of the portico last above referred to is admirably proportioned to the rest of the composition, but its pitch would be absurdly flat if applied to a tetrastyle portico. The inclined sides of a pediment are covered by a cornice similar to that which forms its base, except that all blocks, modillions, and dentils are omitted, even if the bed-mould itself be retained, and a cymatium superadded.

Cornices, &c.—Although a perfect entablature should not be applied to crown an edifice, except it be in connection with columns of some sort, or their legitimate representatives, piers, yet a single cornice, or a cornice and frieze, is not so; and it forms the most pleasing termination to an elevation in which columns are not used. The proportion of one or the other may be best found by setting out a columnar ordinance of the style preferred at the height of the elevation; and the size of the cornice or cornice and frieze thus given will aptly become it. The Vignolan or block cornice, in which the frieze is occupied by cut blocks, is exceedingly effective: it is this which Sir Christopher Wren has employed in the upper Pl. LXVI. entablature of St Paul's, and Vignola himself in the front Fig. 2.

Composition.

of the Villa Giulia. With these cornices rustic quoins consort very pleasingly, and so they do indeed with all single cornices which are of a bold character, and all such should be so.

Pl. LXII. *Arcades, &c.*—The most graceful average proportion for these is, that the opening be twice the width of the pier, and twice its own width in height to the crown of the arch. The practice of the Italian school in the composition of arcaded ordinances may be generally followed with advantage, except in mingling and confusing them with columnar. The pier is based by a deep square plinth, and surmounted by a square or moulded cap or impost, the upper surface of which is the base line of the arch. In rusticated work the radiating stones of the arch show their joints, and are cut to a uniform appearance with the ordinary surface of the wall. In other cases there is a moulded archivolt, whose width varies from an eighth to a tenth of the opening of the arch. A dropping keystone is generally used; but this very much injures the simplicity, and consequently the beauty of the arch, and should be avoided.

Doors and Windows, &c.—The most approved proportion for these apertures, also, is twice their width in height. In an elevation which comprises several tiers or stories, it is customary to make those of the lowest or ground story rather less than that proportion in height; those of the first or principal story rather more; those of the second somewhat less again; and those of the third (if there be so many) square or even lower. If, however, the elevation consist of but two, the ground story should be the principal, and its windows of the most importance (if any difference be made between them at all), those of the upper story being then less than the stated proportion in height. The modes of ornamenting doors and windows are so various, and they depend so much on the coherent parts of the composition, that it is impossible here to go into their varieties, or to give particular instructions for their adaptation. The practice of the Italian school may in this case also be generally followed, avoiding those things in it which are injurious, and referring to the Greek for the details of mouldings and ornament. The application of a columnar ordinance to every door or window, giving it the effect of a little edifice in relief, exemplified by the windows of the principal story of the Farnese Palace, must be censured as injudicious; and so must pediments of all kinds, but particularly those formed with circular lines, or lines twisted in any way, or, though right lined, not meeting in a point at the apex. In basements or ground stories windows or doors may be lined with rustic courses with good effect, though the face of the wall be not rusticated; and if it be so, no other lining is thought necessary. The windows of a principal story may be lined with an architrave, either quite straight or returning in knees at the head, and resting on a continuous blocking course below. This architrave may be surmounted by an enriched frieze and cornice, the former bounded at the ends, and the latter upborne by trusses or consoles, which may rest on or be affixed to a species of pilaster, outside the architrave, and parallel to it; if detached sills are preferred, a shorter and bolder truss may be judiciously applied below the sill, under the foot of each pilaster, to complete the composition; the architrave is generally a sixth or a seventh of the opening in width, and the console and its pilaster about a ninth or tenth. Upon no account should rustics be run through the architrave lining of a window, as on the flanks of St Martin's Church in London. A series of circular-headed windows conjoined, as in the earlier works of the Venetian school, is productive of a pleasing effect; but the large circular-headed, with two conjoined smaller rectangular windows, found in the later works of the Italian school, and called Venetian, is radically inelegant; and there is such a one in the east end of the structure last mentioned. Blank windows should be recurred to as seldom as possible; and when they cannot be avoided, they should have sash-frames and sashes as if they were real windows, otherwise they give a maimed effect to an elevation.

Niches.—There are very few cases in which these do not act injuriously on a composition, from the difficulty of making them cohere with the other parts: the usual mode in Italian practice is to give them the effect of windows, which cannot be approved of. Internally they may be used with much better effect than on exteriors. If a niche is intended to receive a statue, it should have a circular head; if a vase, it will perhaps be better straight: the plan of a niche is semicircular.

Parapets.—The pierced parapet or balustrade is not inelegant when the forms of which it is composed are simple and chaste, as piers; but the close continuous parapet is generally preferable, because of its greater simplicity, and its accordance with the principles developed in the most classic works of architecture. The parapet of a projected balcony, to give an appearance of lightness, may perhaps be better pierced; but if a stereobate continue straight through a window without projection, it should remain close and uncut, unless there exist some special reason for wishing to make the window appear so much higher.

Balconies.—These, whether continuous or broken to every window, act for the most part injuriously in a composition. In the former case they cannot be kept sufficiently under not to appear of too much importance; and in the latter they have the effect of a broken cornice or entablature. In both cases, when a balcony is above the eye, it destroys the proportion of the windows opening on it, by intercepting more or less of their height.

Proportion and Arrangement of Rooms.—Whatever the length of a room may be, it will not be disagreeably proportioned if its height and breadth are the same; and if the length may be limited, once and a half the breadth is the most pleasing. Galleries, of course, will be much longer than that proportion; and corridors will necessarily be narrower than they are high. Entrance-halls should be cubical, regularly polygonal, or circular. Access should be given to a room by the end; it should be lighted on one side, and the fire-place may be at the other end, or on the other side: if the former, there should be two doors, or one and the appearance of another, that the fire-place may not be immediately opposite to a door. Many things, however, from locality and otherwise, frequently occur to make it practically impossible to attend to such suggestions as these. In halls and saloons not commanding a pleasing view, the windows may be advantageously placed above the usual level, for agreeable effect, for light, and for ventilation. In rooms lighted from above, as the Pantheon in Rome is, a columnar ordinance may be judiciously applied; but otherwise columns and their accessories can seldom be well disposed internally.

Chimneys.—If a chimney be in the end of a room, it should be similarly proportioned, the height and breadth of its opening corresponding with the height and breadth of the room; if it be on a side, it should be somewhat wider than it is high; if the room be longer than the sesquialteral proportion, it should have two fire-places, either at the two ends or equidistant from the centre of one of the two sides. The chimney-piece should be bold and massive, not frittered into small parts and much moulded; it may, however, have its vertical faces enriched with great advantage.

Ceilings.—The ceiling of a room should be nearly plain,

but it may rest on a bold and enriched cornice, not composed like an external cornice, as it is differently lighted, but with deep covings instead of broad flat surfaces. Such cornices are highly susceptible of ornament, and they may have additional effect given to them by means of colour. In large rooms the area of the ceiling may be pleasingly contracted, and so made to appear lighter, by coving the angles altogether, and thus bringing the cornice on which it rests lower down on the walls. This mode of arrangement is used, too, in the small rooms of a lofty story, to take off from their too great height. The horizontal surface of a ceiling may be treated like a large panel, with broad borders and slight sinkings; or, if it be very large and lofty, coffering or panelling all over, with moulded or painted ornaments, will produce an agreeable effect. Domed ceilings should be coffered, especially when they are lighted from above; but if the light be from below, as in St Paul's and St Peter's Cathedrals, ribbing is far better. Heavy cumbrous masses of foliage in a ceiling should be avoided; frets, guiloches, and arabesque ornaments, are the best suited enrichments for a ceiling on which ornament is necessary.

Stairs.—In a structure whose principal apartments are on the ground floor, the staircase is a secondary consideration, and should be secluded; but where they are above the level of the entrance door, it becomes an important part of the interior, and should be of immediate and easy access. The rise of a step should not be more than six inches, and the tread not less than twelve. In a square staircase winders should not be used; and in no case should there be more than ten or twelve flyers without a quarter or half space, both to prevent fatigue in ascending, and to avoid even the appearance of danger in the descent. Winding staircases are less convenient and less pleasing in effect than those which are square and without winders. Much room may be saved, however, where it is of consequence, by using the former. Handrails should follow the character of the staircases to which they are attached; but a somewhat square form, with the sides or edges moulded, should be given to them under all circumstances, because of its simplicity, as well as the greater degree of firmness or solidity which the whole composition derives from it, both in effect and in appearance, than can be acquired for it otherwise. The handrail and balusters of an in-door staircase are indeed but the parapet of an external flight of steps, or of a terrace, executed with more lightness and a greater degree of delicacy because of their location. The balustrading, also, should therefore be characterized by boldness and simplicity, though it is indeed a difficult thing to compose with propriety, because of its inclination, and the want of parallelism between the graduating base formed by the ends of the steps and the hanging level of the coping or handrail. The first step of a staircase has a voluted or curtail end (or ends if it be insulated, as in a staircase with a double returning flight) supporting a column or newel, on which the voluted or scrolled end of the handrail rests. The steps of a staircase are wrought with moulded nosings, which are returned at the exposed ends; the under surface is either cut straight and parallel to the inclination of the flight, or moulded to form a sightly object when seen from below.

Mouldings and Ornament.—The Greek examples offer the most beautiful forms for mouldings, and the Grecian mode of enriching them is unsurpassed for beauty and efficiency. By adhering to them, and observing the manner in which they are produced and combined, it will not be difficult to produce and combine mouldings in sufficient variety for every purpose.

For ornament the Roman examples may vie with the Greek; but in composing or adapting, it is necessary to avoid alike the tendency to too great luxuriance in the one, and to poverty in the other. The remains of Herculaneum and Pompeii have furnished us with a great deal of ornament that is new and beautiful; and much that is excellent may be found on the earlier architectural and sculptural monuments of Italy of the middle ages.

It should nevertheless be always borne in mind that the object in architectural enrichment is not to show the ornament, but to enrich the surface, by producing an effective and pleasing variety of light and shade; but still, although the ornament should be a secondary consideration, it will develope itself, and should therefore be of elegant form and composition, as well as the means of producing a good effect on the surfaces to which it is applied.

Of Vertical or Pointed Composition.

The towers of Westminster Abbey are an excellent practical illustration of the essential difference which exists between the horizontal and vertical styles of architectural composition. In general form they belong to the Pointed style, and in so far cohere with the structure generally; but the running lines of the buttresses, if their quoin piers may be so called, are constantly intercepted by transverse cornices; and all the details are strangely in discordance with the character derived from the pointed arch.

Buttresses in a Pointed composition must not be considered simply as abutments to the arches and aids to the walls of a structure, any more than a cornice in horizontal composition may be thought only necessary to cover or protect the wall on which it rests. That these were the uses for which they were severally applied originally, cannot be doubted; but although such may be their purposes, we must now consider them as aids to architectural effect. Buttresses, then, are of the same use in the vertical style that cornices are in the horizontal—to give character to an elevation, by throwing a mass of shadow, to relieve it of the monotony necessarily attendant on a flat surface, however it may be pierced or enriched. The sides of the buttresses should be either quite perpendicular the whole height they have to run, or be slightly diminished, if the wall behind them diminishes, in lengths and not by inclined lines. Their faces also must run up vertically to the sets-off, and these should be in the same inclined line, and that line pointing to the apex of their pinnacles, when pinnacles surmount them. Indeed it cannot be too strongly enforced that there should be a constant tendency in the outlines of compositions in this style to meet, although the surfaces be themselves so generally perpendicular; and the more acute the angle under which they incline, the more graceful and becoming the style the result will be. The commanding lines of every part of a composition should lead through from its summit to the base. Thus, a spire or pinnacle should rest on a tower or turret whose angles are not interrupted, but never on a merely flat wall, however it may be faced with buttresses to give an apparent projection. Neither should low porches be projected from the face of a structure, for such can only have the effect of excrescences, and tend to injure a composition; nor should external doors be made but in places where the harmony of the composition is not injured by them as irregular apertures. Internally, square forms are seldom used; but piers consist of clustered cylindrical shafts, and thin shafts of the same form, lofty, and uninterrupted by crossing lines, act as pilasters. On these, capped with deeply inflected congeries of mouldings or foliage for the former, and lighter ones made continuous and breaking round them for the latter, rest the arches and arched ceilings. Flat surfaces are susceptible of high enrichment by means of tracery and panelling

Supplement.

mouldings are enriched, not by carving on them, but by rounding out foliage and other ornament in covings and other deep inflections. Corbels should not be substituted for shafts to support arches when it can be avoided; but they have a pleasing effect as supports to the dripstone or canopy of a door or window; and indeed there are many other situations in which they are almost necessary, but they should always be considered as succedaneous, and not as necessary to a composition.

To avoid glaring inconsistencies in composing, it will be well to adhere generally to the style of some particular period, and to employ the proportions and enrichments, as well as the forms, peculiar to it; but, nevertheless, a more ornate may superimpose a plainer part, so that the difference be not violent. Windows of the second period may be placed over an arched composition of the first, and appear naturally to result from it; but the transition would be so great from the first to the third, as to make the result inharmonious. It need not, however, be denied, to those who feel themselves competent to use the materials with good taste and propriety, to select matter from examples of the various periods, and make compositions not exactly in the style of any of them. With a clear perception of the principles of the style generally, which we have endeavoured to point out, and a practical acquaintance with the classic exemplars of it, such may certainly be produced; and they may as certainly be adapted to all the purposes to which any style of architecture can be applied.

Rules for practice might be made to infinity, but they are unnecessary in this case, there being no authorized modern practice, like that of the Italian school in horizontal composition, to counteract. It is but to use the forms, proportions, decorations, and enrichments, and follow the mode of combination, which appear in the examples: these, with constant reference to the principles we have attempted to develop, will be the surest and safest guides in composing and arranging any subject. They are, too, so rife with materials for general purposes, that few cases can occur in which there need be any difficulty in finding parallels. Buttresses, piers, shafts, arches, pediments, parapets, turrets, pinnacles, windows, doors, niches, ceilings, tablets, with mouldings and ornaments in great profusion,—indeed almost everything that can be required in practice,—appear in existing works of the pointed style; preventing the necessity of determining from the mode of procedure in one case how we should act in another, as the comparative paucity of materials in the Greek and Roman remains rendered it necessary to do in developing the horizontal style. (W. H—G.)

Supplement.—1853.

The science of architecture is the same in 1853 as in 1829-30, when the preceding treatise was written; and what was true in respect of architecture at the earlier date is true at the present time. But it could hardly happen that, in any treatise upon a subject so comprehensive and so widely ramified, there should not be something to explain, and to amend; and that, with longer experience, and, it may be hoped, increased knowledge on the part of the writer, there should not be something to add.

But as the foregoing treatise, published in a separate form, together with another and more purely technical treatise by the same writer, had become to some extent a text-book to the student, as well as an authority upon its subject in an established book of reference, it has been thought better,—there being nothing in its statements to unsay,—to let it stand unaltered save by the correction of a few patent errors of the pen or of the press, and to add, by way of supplement, a concise view of architecture in its broader and more catholic form, together with the results of discovery and investigation, as well as to bring the subject as exhibited in practice down to the present time.

In treating of architecture in an encyclopædia, the information of the general reader, or of the student seeking to be generally informed upon the subject as a branch of education, is to be regarded rather than the instruction of the professional student; and in an encyclopædia for English readers, reference to English, and more especially metropolitan, instances would seem to be more useful, because better known, than foreign or provincial examples. Illustration by diagrams to any great extent is practically impossible in a work which purports to trace the whole round of human knowledge, and which ought therefore to give an equal rate of information upon every subject profitable to the human mind, and useful to the social human being; but which must be itself, at the same time, kept within comparatively narrow bounds. Reference is made, nevertheless, to provincial or to foreign instances, where they are of such a character as to be generally known by published representation, so that the remarks made may be thereby generally intelligible.

The main defect of the treatise on architecture consists, in the estimation of its author, in the narrowness of its range and in insufficient reference to construction. It takes the artist's view rather than the architect's, and makes the mere adornment the prominent subject; taking the vulgar view of architecture, indeed, which does not regard the causes within, but which looks only to what may be, and too often is, the factitious outer form, leaving aside all consideration of that which can alone give consistency and propriety to the outward presentment. This is truly the vice of almost all that has been written on architecture under that name. Architecture, in the broad sense in which it really exists, and in which alone it ought to be understood, has been ignored, and the world has been content to take the shadow for the substance. Construction, including in the term the disposition of a building with reference to its uses, is commonly taken to be to the architect what the lay figure is to the painter and the sculptor,—an articulated machine upon which to hang drapery,—and it is, by the great as well as by the little vulgar, both lay and professional, esteemed, and by some designated, the common part of the art. But construction, taken in its double sense, is really the bone, marrow, muscle, and nerve of architecture; and the arts of construction are those to which the true architect will look, rather than to rules and examples, for the means of producing two at the least of the three essential conditions of building well —*commodity*, *firmness*, and *delight*—which conditions have been aptly said to be the end of architecture as of all other operative arts[1].

A true architect, who arose and flourished, and has passed away within the period that has run out since the writing of the foregoing treatise, said, with equal truth and point, in commencing a lecture on architecture, which he published in 1841, and entitled *The True Principles of Pointed or Christian Architecture*,—though the doctrine is alike true in respect of every style of architecture,—"The two great rules for design are these: 1st, *That there should be no features about a building which are not necessary for convenience, construction, or propriety*; 2d, *That all ornament*

[1] "In Architecture, as in all other Operative Arts, the End will direct the Operation.—*The End is to Build well.*—Well Building hath three Conditions; *Commodity, Firmness, and Delight.*" (*The Elements of Architecture*, by Sir H. Wotton, Knt., Part i. p. 1.)

should consist of enrichment of the essential construction of the building. The neglect of these two rules is the cause of all the bad architecture of the present time. Architectural features are continually tacked on buildings with which they have no connection, merely for the sake of what is termed effect; and ornaments are *actually constructed* instead of forming the decoration of construction, to which, in good taste, they should be always subservient." [1]

A glimmering of the truth here enunciated had led the present writer to remark, under the head "Principles of Architectural Composition" (*ante*), that "the object in architectural enrichment is not to show the ornament but to enrich the surface;" but it was reserved for Mr Welby Pugin to see it clearly and to state it fully. It is in propriety or fitness that the condition of delight which Sir Henry Wotton claims as one of the three conditions of building well, that architecture consists, and not in inconsistent devices.

The readiness of the world to accept the shadow, outward presentment, or even mere colour, for the substance, architecture, of which the true embodiment is construction, has made it the aim and pretence of the student in architecture to be an artist rather than a constructor, instead of grafting the artist upon the constructor. In the practice of the law the graces of oratory are taken to be of value only when supported by the sound learning of the lawyer; and in the practice of architecture the taste of the artist ought to be held merely ancillary to truthful disposition for structure and service.

But the soundest constructor is the most apt in the production, or the reproduction it may be, of real art. If Welby Pugin had been the mere artist-draughtsman his father was, which alone he might have been but for the superadded skill of the carpenter, and thereby of the constructor, he would not have arrived at the truth in respect of building well; nor have built so well and with such excellent effect as, in his brief lifetime, he did. The mechanician Smeaton, and not a mere artist architect, was employed to build the Eddystone lighthouse, and the means placed at his disposal being truly directed to the end aimed at, the result obtained presents a compendium of commodity, firmness, and delight. The Eddystone lighthouse is well adapted to its uses; that is to say, it is commodious, it is firm and stable almost to a miracle, and its form is as beautiful in outline to the delight of the eye, as it is well adapted to break and thereby to mitigate the force of the sea in defence of its own structure. Smeaton was in that work a true architect, the artist engrafted upon the constructor; whereas in dropping uncombined stone rubble into the Thames about the piers of old London Bridge to protect the bed of the river, and thereby the foundations of the bridge, from the scour of the already pent-up stream; and in building Hexham Bridge after the manner of old London Bridge, as to the effect of the piers upon the stream, and after the manner of Westminster Bridge as to the character of its foundations, Smeaton might have been taken for nothing more than a mere artist architect. In like manner, the botanist and landscape gardener, Paxton, having learnt to help himself in the contrivance and construction of works of architecture of a kind adapted to the purposes of his art, had become qualified to suggest the employment of a material unthought of by professional architects—though as ready to their hands as to his, and often misused by them—as the main constituent of a structure, and to devise a plan by which the material employed might be applied alike with constructive propriety, with marvellous rapidity, and so, moreover, as to produce a magical effect, in a Conservatory designed to fulfil, and amply fulfilling, a noble object, which must, probably, have failed for the time, or have been carried out in an ignoble manner, if the horticulturist-architect, Paxton, had not already himself learnt to be a constructor. And this was in default of wide-reaching knowledge of construction on the part of professional and practising architects, and so-called engineers, so far as the results of an invitation to prepare and to submit designs for such a work can be taken as evidence of the knowledge, talent, and imagination of the architectural profession; for the invitation was general, and it went far and wide, and was largely responded to even from beyond the bounds of the British Islands. The Great Exhibition building in Hyde Park, originated by Sir Joseph Paxton, possessed in an eminent degree the qualities arising from the conditions of commodity, firmness, and delight; it was most commodious for the purposes of an exhibition; it was firm enough for the temporary service required of it; and there was delight in its luminousness and in the simplicity and truth of its combinations; and all this may be said to have grown out of propriety of construction as applied in and to the material, cast iron.

The use of unfitting materials on the other hand, or the employment of fitting materials inappropriately, leads almost certainly to incommodiousness, infirmity, and offence, or some of them. The bearing towers of suspension bridges are commonly built of masonry, and being so built, are of necessity massive, and being massive they tend to narrow if not to obstruct the way,—the necessity of the construction in most cases requiring that the towers shall intercept the footways, whereby the pedestrian is compelled to take the carriage-way; or for the same cause the way is narrowed if it be but one, as in a foot bridge. In the Brighton Jetty, conventionally called the Brighton Pier, the substructure of the bearing towers is of timber in piles, upon which are raised trestle-like frameworks—standards, they may be designated,—and these are made to present the outward form of towers, as of masonry, by casing them with cast-iron plates to that effect, and as if to keep up the false character thus given to the standards, they are so arranged in plan as to obstruct the way along the floor of the jetty.

Cast iron in its proper character, and in the forms which the duty to be imposed requires it to assume, would not be more inappropriate as the material of a superstructure upon piles of timber, than a tower of masonry is; and an open structure well composed of cast iron to form trestle-like framework, would, in the case of the Brighton Jetty, have left the bridged way wholly unobstructed and convenient for use.

At Rouen there is, over the Seine, a wire-rope suspension bridge in two bays; the ropes are anchored at the banks and carried over a bearing structure which is founded on an island in the middle of the river. In this case the substructure of the bearing tower, if it may so be called, is, properly enough, and as it conveniently might be, of masonry; but the superstructure is, as to the main supports of the suspending ropes and their load, in fact of cast iron disposed as columns about the piers of arches; so that the iron structure takes the appearance of a structure of stone, whilst the proportions are those appropriate to the stronger material of which it is, and not of the weaker material of which it pretends to be. The result to the eye is what might be expected. The bearing structure which, being of iron, is sufficient to carry the bridging way, pretending to be stone presents the appearance of excessive weakness; while as cast iron, properly disposed with reference to the duty required of it, the standard would have been not only strong enough, but it would have appeared to the eye to be so.

[1] *The True Principles of Pointed or Christian Architecture*, by A. Welby Pugin, Architect, &c., p. 1.

Section I.

The practice of architecture in whatever form, and under whatever alternative designation it presents itself—whether as civil architecture in works upon and above ground to be covered from the weather, or as civil engineering in works upon and in the ground and exposed to the weather—consists in originating, designing, composing, and arranging in detail, specifying, estimating, directing, and supervising the formation, construction, and fitting for use of works, and particularly works of the nature of buildings for the use and convenience of man, and mainly of social man in civilized communion.

Originating involves the devising a practicable scheme for effecting any desired object in the manner the best adapted to the end.—A canal, a road, or a railway, is required between any two places. By the aid of hydrographical maps and by personal exploration of the country, the most fitting line the country affords may be struck out and laid down; and by investigation of the levels, examination of the soil, computation of the available quantity of water at the summit in the case of a canal, and inquiry into the cost of labour, and of the various materials necessary for the work contemplated at the place where they are to be applied—the cost of land and the contingencies connected with its tenure and occupation—the line struck out as naturally the most fit, is modified to the most economical in execution, consistently with efficiency and economy in its use.—A town, or a new quarter of a town, a new street or a single house or other building, is required; the town, or part of town, the street, the house, warehouse, or workshop, is to be considered first with reference to the essentials, *commodity*, *firmness*, and *delight*;—and it will be convenient and salubrious, or unfit and probably the seat of disease—it will be cheerful and agreeable, or dull and cheerless—and, although the commercial estimation may depend on circumstances beyond the control and not wholly within the modifying power of architecture, even wealth or poverty may result from the propriety or impropriety with which the work has been originated.

Designing includes the bringing together and combining in the most efficient manner permitted by the circumstances of the case for convenience in use, all the parts of which a work may consist, shaping the parts within themselves to the duties they are respectively to perform, or to the uses they are to fulfil; adapting the work to the materials which necessity, prudential economy, or luxury may dictate; giving, indeed, a congruous body to the originated idea. The origination of a bridge has determined its position, the manner in which it shall lie across the river or whatever else it is to be built over—the manner in which it is to be approached—the waterway, in the case of a river, that may be occupied by its substructions, or rather the waterway that the bridge must leave unobstructed—the headway that must be preserved under it, whether for navigation or for flood water, and with reference to the country above it or to its own security—the level or other inclination of the roadway, and the materials of which the bridge shall be composed, together with the general outline of its form, determining thereby the class of composition to be adopted. The design gives form and consistence to the outline—it arranges the spans, bays, or openings—proportions the solids to the voids—determines, upon close and minute investigation of the site, the depth, mass, and composition of the foundations, and how they shall be executed—settles the form and rise of the arches, and prescribes the requisite appliances in erecting them, as centering and scaffolding—shows the mode of composing and constructing the roadway, and provides all the requisite accessories in completing the work for use.

Composing and arranging in detail are further preliminary considerations, and fall strictly, perhaps, within the province of design. These comprise the artistical and constructive adaptation and adjustment of the materials in the forms and combinations in and by which they are to be placed and held together to fulfil the ends of the design—the degree of finish that shall be given to a work, and the means by which it is to be brought about, as well as the modes of combining the parts and protecting them from injury from whatever source, whether from influence within the substance of the materials to be employed, from those which may be brought to bear upon them in the use of the finished work, or from external influences in and through the atmosphere. The composed and arranged design is exhibited in clearly expressed and accurately executed drawings made to scale—the scale being in ordinary English practice some aliquot part of a foot, or of an inch as an understood division of a foot—and the drawings being plans, sections, and elevations in general and in detail, made, by colouring, or by hatching, and by written descriptions, to express the main component materials severally and distinctly.

Specifying is a describing in writing everything required to be used and applied, and the modes of using and applying all the matters proposed to be incorporated in the work, to give effect to the design, the specification having reference to the drawings, of which it is, indeed, a further expression in words; with the addition of a description of the kinds and qualities of the materials to be employed, the modes of operating upon them, the sequence of the operations, the time to be expended upon them, or within which they are required to be effected (for time has always an important influence upon the cost of a work), and the result to be produced; and this must be done in such manner as to render misapprehension or misunderstanding as nearly impossible as knowledge and perspicuity can make them.

By estimating is understood the computing the quantities of materials of their various kinds required to be used or applied in the execution of a work; the power, whether it be that derived from inorganic matter through the aid of machinery, or from the labour of beasts of draught and burden, or of men, and the labour of skilled workmen as artizans necessary in procuring the materials, and in preparing, shaping, and applying them to effect their combination in the manner and to the end proposed; and, furthermore, the cost of such materials and labour, together with all the charges and expenses proper and incidental to the execution of the work according to the drawings and specification.

Directing and supervising the execution of a work imply the instructional explanations the workmen may require while the works are in preparation and progress, and the overlooking them to see that they do properly what the drawings and specification require to be done. In the case of a contract for the execution of a work, the effective directions must be supposed indeed to appear in the drawings and specification, and so that supervision shall be only necessary to secure adherence to such directions.

"In architecture, as in all other operative arts, the end is to build well." But, with whatever limitation in his own mind Sir Henry Wotton may have made that declaration, the conditions of well building declared by himself, give a much wider meaning to it than the words are ordinarily taken to convey. Architecture in its broad and catholic sense admits of no limitation—it is subterrene as well as superterrene, formative as well as structural, and includes the general disposition of a site as well as the particular arrangement of the parts into which it may be divided. It is thus applicable to towns, or aggregations of buildings, as such, as well as to the individual buildings which go to make up the town, and ought to be applied in such manner that the general result, in building a town, shall be in accordance with the conditions, and that they shall be fulfilled in the aggregate

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as completely as they are required to be fulfilled in each particular building which may go to compose it.

In the choice or selection of a site for a town, intrinsic circumstances,—some peculiar advantages in a commercial, or a merely pleasurable, or it may be indeed a military point of view,—commonly determine the general question, and impose upon the architect to fit it in all particulars for the contemplated purpose. Whether the site have the advantage of railway communication, or not, easy access by carriage-roads must be provided; which roads must be laid out, and set out with such inclinations proper for use as are attainable; bridges and culverts must be built to carry the roads over streams and gullies, and they must be cut, formed, drained, bottomed and metalled, or otherwise paved; quays to the river or the harbour must be arranged and formed, or embanked and constructed,—encroaching upon the tideway, or widening the waterway as the case may require; or, in the absence of natural facilities for navigation, it is a question for consideration whether artificial navigation can be obtained, and how and in what manner the arrangement of the site may be modified to render it available, or whether a railway may not be preferable to any other mode of giving commercial access to the town; the site of the town must be drained, both as regards water in the ground, and surface water, and the soilage must be taken off in a fluid state; water must be led to, or be raised by artifice within the site of a town, and accumulated in reservoirs at such levels that it may pass freely from them to all the parts of the town, and to the highest contemplated building in it. In the distribution of the parts of a town, not only are the requirements of the community as such to be considered, but the particular requirements of every class of a community ought to be provided for. There should be public markets and bazaars, and there should be also provision made for shops and warehouses, from which those who may choose to take their supplies may obtain them without recourse to the public markets. There may be within every town exclusive gardens, as in squares for the use of those who, dwelling around, may undertake to maintain them for their own use; but there should be certainly places as gardens, maintained at the public expense, open to general use for the resort and recreation of men, women, and children, of whatever class, as well as parks or pleasure grounds in the environs for general pedestrian, equestrian, and carriage exercise and open-air enjoyment. Streets, squares, and public places, should be disposed upon the site with regard to light, aspect, and ventilation; and sites for all requisite public buildings, sites for the requisite varieties of private dwellings; and places for storing, manufacturing, and commercial buildings and establishments, according to their kinds and requirements, are to be provided and arranged, and so provided and arranged as to produce the greatest possible general convenience, as well as to be capable of producing private benefit. Towards effecting these objects everything likely to be offensive should be placed to leeward, having regard to the prevailing winds. The relative levels of the lowest floor of buildings in every case to the drainage level should be settled, and provision made for the ventilation by legitimate means, of the drains of every building, so that it be not left to chance, or to the ignorance or caprice of individuals in building in detail, whether the town may be pleasant and wholesome, or be the seat of discomfort and disease.

There are certain essentials to every building which it is within the province of architecture to provide, and within the duty of the architect to secure. There must be convenient and easy access to the building itself; protection from water from whatever source and in whatever form water can present itself,—from the earth or from the skies,—by the foundation or by the roofs,—as water supplied for use, and as foul water or water the vehicle of the foulest matters;—air is to be supplied to the interior by legitimate channels from the best accessible source, and the ejection of vitiated air provided for and secured, and so that there be ventilation without injurious draughts; and light is to be admitted and diffused, so that every part of an interior may be appropriately and sufficiently lighted, and lighted from the general source directly, or with as little recourse as possible to borrowed and artificially created light; equal temperature throughout the varying seasons is to be maintained by making provision to check excess of heat at one season, and by the promotion and diffusion of heat to warm at another. Next to the general essentials—which are as much so to a penitentiary or to an hospital as to a palace—are the particular arrangement and distribution of buildings according to their respective uses, with reference to the demand which the use may make or impose. But the uses of buildings are so various, and the requirements of each particular use so different from those of every other in all the classes of buildings, while every individual building of a class may be forced into peculiarities of disposition, dictated by site and other circumstances, that no general rules can be laid down for the design of buildings in classes, or severally, without running too much into detail for the pages of an encyclopædia. These are, or they ought to be, the special study of the architect, the merit and value of whose services consist mainly, indeed, in giving special effect to the general requirements in a congruous manner, and at the smallest cost consistent with efficiency.

It will be necessary, however, to add in this place some observations upon matters which, though general in their nature, are of particular interest to every community. Whether it be in laying out a new township, or in adding to a town, provision should be made for securing that it be done in such manner as may best tend to secure to it commodity, firmness, and delight, or, in other words, the health, comfort, and safety of the future inhabitants. And first, as to the carriage roads leading into and out of a town. No such road should be permitted to have a greater inclination in any part than one in thirty, such being the maximum at which ordinary four-wheeled carriages will remain at rest upon a well-made road surface. The width of the carriage roadway, clear of any side drains, should be such as to permit three carriages abreast, taking one to be standing on one side or the other, and two in motion, meeting or passing. Eight feet should be allowed to the carriage at rest, and ten feet to each of the carriages in motion, making twenty-eight feet as the minimum width between the water channels, or at the least thirty feet clear between the footways; for there ought to be to every such road a footway on each side, and each of sufficient width for four persons, two and two meeting, to pass abreast; and this requires eight feet at the least, so that there should be in the whole little short of fifty feet of public way wholly devoted to the public in what may be termed the country roads about a town where there are no houses, or but few, before which carts or carriages of any kind can be required to stand.

In laying out a town, there need be no mere lounging places provided, such as the paved area of Trafalgar Square in London, or as the *Place* so common in the towns and cities of the Continent. Markets should be provided for in sheltered and inclosed buildings, and not be held in a *place*; and a more than equivalent for the *place* or even the village green ought to be provided for outdoor recreation, and, it may be, rest; but wholly irrespective of business. To this effect plots of from five to ten acres each, making in all not less than one-tenth of the whole area, should be reserved in laying out a town, or in adding to a town; such plots being so disposed as not be more than a short half-mile apart, or so that there shall be one such plot within less than a quarter of a mile (a sufficiently long walk at once for a child, or for a woman or a girl carrying a baby) of every domicile; and every such plot inclosed, but accessible on every side,

and laid out in the best manner to make it a pleasant resort at all times for men and women seeking rest or healthful recreation, and as a play-ground for children. With such a provision in a town, idle men and boys may be reasonably required by the police to "move on;" and with almost equal advantage to children and to the community at large, the trundling of hoops in the streets may be prohibited; whilst river or sea-side quays for business, or terraces for pleasure, need not be the permitted haunts of thieves and beggars. Out of a ten-acre plot (the size of the whole area of Russell Square in London,—and about that of Lincoln's Inn Fields, up to the inclosures before the houses), one acre disposed in four distinct quarters of an acre may be assigned to the four essential requisites of every hundred-acre area in a town—a church, a school, a library with reading-rooms, and a building to contain baths and washhouses; one at each of the four corners of the Town-Garden, in its own quarter-acre plot, and each communicating directly with the garden as well as with the streets by which, if houses or other buildings front towards it, the garden should be belted, without taking them out of the ten-acre area. The town-garden need not supersede the square and its garden, which may be formed, and the garden maintained in all its exclusiveness, with great public benefit, wherever the prospective demands of a future population may seem to require squares in connexion with the streets, by which and by the buildings fronting to them, the greater part of the whole area will certainly be covered. Nor need the town-garden vie with the square-garden in the relative extent of its plantations, or in the picturesque disposition of its paths. It should be laid out with broad walks, and hardily-turfed lawns; it should have a fountain, and trees should not be wanting; upon the whole, more like Hyde Park, the Green Park, and the public grounds of the Regent's Park, than like the too elaborately beautiful grounds of St James's Park. The town-garden should not be too delicate for cricket and quoits; nor should it be supposed to render the suburban park a superfluity: the town-garden for children in the day, and for work-day evenings for men and women, and the park for holidays.

The courses or directions to be given to streets must be greatly influenced by the circumstance of the locality, whether it be plain or hilly, and greatly by the climate, whether sunshine or shade is more to be desired. No general rule in this respect can be laid down; but having reference to the high latitude in which the British Islands are placed, and the consequent obliquity of the sun's rays at all seasons, without great intensity at any season, the light and heat of the sun are to be sought and not to be evaded; and these are more equably diffused, and the roadway exposed to the sun's rays more certainly, the more nearly the direction is that of the meridian. Perhaps, however, it is of more importance that buildings of whatever kind in which human beings are to live or to labour, shall be so disposed, that every room in every such building shall be capable of receiving the rays of the sun at some time in the course of every day that the sun shines.

The width of a street—and by the term street is intended any line of communication, whether adapted for carriages or not, in and through a town having houses or other buildings fronting to it on both sides—ought not in any case to be less from front to front of the buildings, taking an even course, than the height of the buildings, the dimensions of which—the street being once formed with such limit to its width—it ought not to be permitted at any time to exceed, without setting the higher buildings back accordingly. To this effect it is necessary to determine in what manner the height of a building is to be ascertained, the object in view being the due ventilation of the streets as a means of assuring a sufficient flow of air to the buildings, whereby they in their turn may be duly ventilated.

Take a minimum width for a street—say 30 feet—as a horizontal base line transversely of the street, and at a level, say one foot lower than the level assigned, in manner hereafter described, to the floor of the lowest story of the contemplated buildings. Erect a perpendicular line upon each end of such base, and bisecting the inner angles, draw lines which—the angles being right angles—will of course intersect the opposite perpendiculars at the height of 30 feet, the limit in height of any buildings standing up to such lines at the limited distance of 30 feet apart; the diagonals drawn out will limit the heights of the opposite buildings as to the roofs or any erections upon the roofs, beyond the perpendiculars. This rule is applicable in like manner to any greater width than 30 feet; but it will be seen that the rule imposes no limit to the height of any building standing in the narrowest street, if the front be set back at the level of the street, or be in any manner arranged by building terrace-wise; or in any other manner to the same effect of falling wholly under the diagonal line drawn from the opposite extremity of the base. Lofty chimneys, towers, and such like erections, of small extent in plan, should be admitted exceptions to such general rule.

The drainage of a town must be settled, and the levels determined throughout the course of every street, square, or other place, before the levels of the road surfaces, and of the floors of the lowest stories of buildings, can be fixed, so that they may be prescribed; but it must be obvious, that no street should be formed, in the technical sense of the term, by making the road at such a level that it cannot be efficiently drained. In like manner, as regards any building; every building should be placed at such a level that the floor of the intended lowest story can be efficiently drained, and in all respects relieved of fluid matters by the means provided; *and the means of efficient drainage should be made, and be in a condition to operate, before a building to be relieved is begun to be built.*

The widths of streets for the purpose last above referred to are to be considered as minimum widths, and irrespective altogether of the widths which ought to be imposed and required in respect of the roadways and footways, as means of communication and of passage in, through, and about a town.

A minimum width of 30 feet from front to front of buildings, ought to allow of no more than a single-line carriage-way in short lengths, or with turning and passing places; such single-line ways being necessary to give access for carts in the supply of fuel and other heavy matters, and for the removal of solid refuse, as cinders, ashes, bones, and other hard rubbish. Shops requiring frequent supplies by carts, and making their deliveries by carts, require greater width of carriage-way, and consequently greater width of street. As the demands of the carriage road for width increase, so do those of the footway; for shops making a show of their goods attract the attention of passers-by, and thereby tend to cause obstruction. Houses built as private dwelling-houses, in streets which are leading thoroughfares, or which become such, may be turned into shops; and when this is done, the space usually retained in towns between the footway and the house should be, for the reason stated, given up to the footway. In respect of the carriage-way, however, no street being, or being in a position to become, a much-used thoroughfare, ought to be of less width from footway to footway than sufficient for four carriages abreast, reckoning one to be standing on each side, and three to be in motion; for if only two be provided for, as in motion, the fast will be checked by the slow, and the whole traffic of a street be interrupted. Space for two standing carriages at 8 feet each, and for three in motion at 10 feet each, make together 56 feet as the least width that should be given to the carriage-way of a leading thoroughfare in any town. Any addition to this should be by 9 feet at the least, or it will add nothing to the convenience of the road. The footways to such

a street, where the houses are private dwellings, may be taken at three couples abreast, or 12 feet at the least, and where they are shops, at 16 feet, allowing 4 feet for loungers. Any bridge occurring in a town ought not to require the carriage-way or road to be as wide, by the two stopping carriages, as the roadways in the streets leading up to it.

The relief of a town from water in the ground, if there be any—of the water that will fall upon it in the form of rain, hail, or snow—of the waste and refuse of water raised or supplied for the use of the inhabitants, in whatever condition the refuse may present itself, must, so far as regards the mode of relief, depend, in the first instance, upon the circumstances of the locality. If the choice of a site for a town, or for an addition to a town, lay between one from which all fluids could be passed away by gravitation, and another the general level of which was so low with reference to the means of eventual discharge that nothing could pass off in a natural course, the inducements to prefer the latter to the former must be great; but cases do nevertheless occur, and when they do occur, means must be applied to remedy the defect. London, in its great extent, contains many varieties, or rather instances of many varieties, of soil and surface; and it seems desirable to show somewhat in detail to what an extent natural deficiencies have been exaggerated in that notorious example of folly and neglect, and so to teach by warning. Suffice it for the present purpose to suggest, that the main considerations in providing for the relief of a town from water in all its forms and with all its concomitants, whatever the means of eventual discharge may be, are,—first, whether there is water in the ground so near the surface as to require to be tapped and kept down; secondly, whether the water falling from the clouds upon the surfaces of the roads and streets, and carrying gravel, sand, silt, and other heavy matters, either not soluble in water, or incapable of being held in suspension sufficiently to be carried along by the obtainable current in a reasonably well-formed drain, but inoffensive, shall be passed into special drains forming a separate system; and, thirdly, whether the rain-fall and other surface-water shall be passed into the system of drains necessary to relieve the buildings of the fluids which, coming through and from the habitations of human beings, are, though foul and offensive, for the most part soluble in the water with which they pass away. It is in favour of the separate system, that surface-water (and water falling upon the roofs of buildings in towns may be to a great extent treated and passed away as surface-water), being taken off at a higher level, may often be discharged by gravitation, that is to say, by natural fall, when house drainage, which is commonly at a lower level, cannot be so. Moreover, surface-water may, without offence, be discharged into rivers and other water-courses, whilst the fluids from houses, being foul, ought not to be turned into any far inland waters, and certainly not into any tidal river far from the sea, if they can by any economical possibility be otherwise disposed of. There can indeed be no reasonable doubt, that if the circumstances of any case be such as to permit the discharge of surface-water, or any considerable part of it, by gravitation, it ought to be so discharged, though it may involve the necessity of a separate system of drains; cloacal waters being permitted to pass down to a low level, though it be to be lifted again by artifice, rather than allow it to contaminate the surface-water, and involve the necessity of lifting this also. But there is the further and important reason for keeping the two kinds of drainage-water separate, even if they must pass at or to the same level, and that a low one. The surface-water being necessarily charged with heavy matters, and commonly taking up lime and other cementitious matters with silt and sand from the roadways, a concrete is deposited in slow-coursed drains, which requires to be removed by manual labour.

Thus, when cloacal drainage and surface drainage go together, the drains must have a greater fall than the former alone requires, to hurry on the surface-waters with their heavy concomitants, and to lead both down to a greater depth than either would require if separate; and this last is the case with London.

Until within the present century, the common sewers of London received surface-water alone. Cloacal matters were not admitted into them, but human ordure and other dejecta fell or was thrown into cess-pools dug deep in the ground; and as London in the eighteenth century hardly extended beyond the limits of the dry gravel bed, the fluids were in a great degree absorbed, and the more solid matters were removed under the name of night-soil by hand-labour, and carried away in carts and applied as manure. But as the clay land became building land, and as the water-closet came into general use, the gravelly subsoil could not take up the increased quantity of fluid matter, and the clays of course refused to receive them at all; so that it became necessary to provide for the discharge in a fluid state of the matters dejected all together. This is done, so far as it is done, by drains into the common sewers, which have thus become cloacal vents, as well as conduits for waste and surface water. As more capacious sewers are found necessary for this double duty, such have been built, and are constantly in course of building, and at such depth that houses may be relieved by their drains of waste-water, and of refuse soluble in water, while the roads are kept drained by the same conduits of their surface-water. The result of such deepening, however, is, that to a large extent the outfalls of the sewers are below the level of high tide in the Thames and its confluent creeks; so that the commingled waters in the sewers are penned back to await the ebb, when the sand, silt, and other heavy and insoluble matters which the surface-water brings from the roadways deposit, and form a concrete which no force of any backwater will wholly remove and carry out at the reflux; and this it is which constitutes the great difficulty in relieving London, and in providing for the discharge of its cloacal refuse—whether for use as manure, or into the river as waste—so much below London, seaward, that it shall not return with the tidal flood to or within the inhabited area. A separate system of drains at the higher level, for the surface-waters, would discharge them with their heavy but inoffensive accompaniments from over three-fourths at least of the whole metropolitan area into the river at high tide, from which the latter return in the valuable form of sand and gravel; but it may be said to be now impossible to revert, and to form a separate system, so many places have been laid out and built upon at low levels upon the faith that what is permitted is entitled to protection. Nothing remains, therefore, but to continue the present abominable condition of London as to the discharge of its cloacal refuse; or to make tunnelled ducts for the commingled sewerage at a depth below the lowest level to be relieved—and practically very much below even that level—and the constant employment of costly artificial means for raising a most unnecessarily large quantity of matter, fluid and solid, from such low level to a level high enough to allow of their discharge without offence; or, as a further alternative, by separating the heavy and insoluble matters from the commingled fluids before they pass down into the low level ducts, where these alone may be very easily dealt with.

The existing practice is condemned, and judgment has been passed upon it, but execution is delayed for want of a feasible scheme for a plan by which to supersede it. Scores of schemes professedly to that effect have been prepared and submitted to the Metropolitan Commission of Sewers in a foolishly invited and unwisely answered competition, but none of such schemes were thought by the commissioners for the time being likely to effect the object sought in an efficient and satisfactory manner. Failing in a general competition which had, nevertheless, produced schemes from

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some men of large experience in sewering, the Commissioners of Metropolitan Sewers instructed their chief surveyor, whose experience is understood to have been that of a supervisor of railway works, to devise a scheme; and he produced one which overcomes none of the inherent difficulties of the case, whilst it presents new ones of its own creation. No available scheme has yet been promulgated for separating the heavy and insoluble matters from the fluids before the precipitation to a deep level of either; and it is to this object probably that attention must be directed. But speculation upon the mode by which success may be attained in a particular case is not matter for an encyclopædia; our object is to show, by the miserable example of London, what ought to be avoided, as a mode of indicating the more clearly what is to be aimed at in providing for the relief of a town as a matter of architectural practice.

The considerations which lead to the choice of sites for new towns are seldom those which have regard to the personal accommodation of future inhabitants. Neither pleasantness of position, nor salubrity of air and dryness of soil, will at any time prevail against commodiousness for the trade or manufacture whereby the community to be established may obtain the means of living and of becoming wealthy. Even facilities for defence are in modern times made secondary to the objects stated, with the certain conviction that wealth can always provide the means of defending itself. The province of architecture is, so to dispose and so to form, that the advantages which dictated the site shall be rendered available and enduring, and that any defects in site, soil, or position shall be remedied—that is to say, so far as artful disposition and skilful operation can bring relief or lead to cure. In like manner as regards the increment of ancient towns. Towns outgrow the sites upon which they were first established, and widen upon soils and at levels which possess none of the advantages which may happen to attach themselves to the ancient site. Whatever were the inducements which led to the first establishment of a town on the site of the city of London—whether the facilities which it presented for defence, or for commerce, or both; or the beauty of the situation, and of the country about and within view from it; or the excellence of its soil—dry, but covering water of the finest quality—there can be no doubt that its facilities for commerce have prevailed, and that they have made it the centre of a province rather than the heart of a metropolis. But in widening as a town, London has outgrown the beautifully environed high ground, with its deep bed of dry gravel, and brought within its area cold clays and low marsh lands; so that it has long become a subject for the application of all the resources of architecture in its most extended sense, and with all the applications that it can bring in aid.

Sir Christopher Wren's scheme for rebuilding the city of London after the great fire, included every consideration that in his time was recognised as essential to "commodity, firmness, and delight;" and it may be believed that Sir Christopher's plan for re-distributing the site, with a view to fulfil the conditions which had been already laid down by Sir Henry Wotton, was not carried out, only because the case was one of *re*-building, not of building; the site had been cleared, but the rights to the ancient though ill-disposed seats or sites remained. The city was refilled with buildings, and many of them were by the great master in architecture himself; but it was not rebuilt architecturally—the buildings may have fulfilled, and certainly many of them did fulfil, the conditions of well building, so far as they could be fulfilled in a town which had not been, as a whole, submitted to them; and the city of London remains to this day, and will remain—notwithstanding the millions devoted at the expense of the metropolis to "city improvements"—a monument of bad architecture.

An urgent reason prevailed against the application of the great architect's plan to the site of the devastated city in the latter part of the seventeenth century; but there is no good reason whatever why the London that has grown up since that time around and about the city, upon the suburban gardens, fields, and marshes, should have been absolved from all wholesome rule in respect of the great conditions of catholical architecture.

Reverting, however, to the city itself, it may be remarked, that under a crushing despotism, commodiousness and delight were firmly established in the capital of France, when its ancient limits were to be extended, by a broad belt of almost park-like avenue being formed upon the site of the demolished fortifications; whilst the civic body that built an obstruction,—which is by the same body still retained,—upon the most crowded thoroughfare in Europe, wherewith to exercise their useless and now unmeaning and absurd power of shutting a door in the sovereign's face—whilst the corporation of the city of London, in the plentitude of their freedom, when they demolished their city walls and filled up the moat with the rubbish, covered the new site so obtained,—not with broad avenues for commodiousness and delight,—but with lanes, courts, and alleys; unless, indeed, Houndsditch is to be called a street. Smithfield might have been a park, or at least a garden connected with Tower-Hill by an equivalent for the Boulevards of Paris, at no cost but that of a little self-restraint on the part of the corporation. Fleet-Ditch might have been converted into a dock with broad quays locking into the river at the south, as the Grosvenor Canal further west now does, and capable of being extended inland as necessity might dictate or convenience require, and so as to deliver fuel and other heavy goods east and west, to the protection of the heart of the town from the heavier traffic north and south, to the present time and for ever. Elevated viaducts thrown over the valley of the Fleet would have connected the main lines of street running east and west; so that the means of personal communication would have been uninterrupted by, and have left uninterrupted, the trade of the lower parts of the sides of the valley and the commerce upon the quays of the dock.

It may seem useless to speculate in this place upon what might have been done in and for London a century and a half or two centuries ago; but there are many old towns and cities which hardly yet extend beyond their ancient boundaries, but which are likely to be subjected to the same process of extension, and are susceptible of improvement in like manner as they become extended. It is, indeed, to the extension of towns and cities by the bringing within the inhabited area of lands not heretofore built upon, and to the formation of new townships, that such observations are more immediately applicable. It may be said with no exaggeration, that the city of London has been twice rebuilt since the great fire, and with no improvement in its condition as it regards commodiousness, that has not been more than counterbalanced by the being hedged in on almost all sides by suburbs in which all the ends of architecture are coarsely and vilely set at nought. Hundreds of acres of land have been, in the vulgar sense, built over, and scores, if not indeed hundreds, of acres more are yearly added to London; every owner, doing what may appear to him likeliest to turn the land to his own immediate profit,—the legislature caring next to nothing for the manner in which such increment is made.

It is only natural that a man possessing land should desire to turn it to the best account, and it is not to be expected that men who possess, whether as individuals or as corporations, should do otherwise in adding their lands to the area of a town than the natural impulse leads them to do. Any man possessing, or having the authority of an owner over land in or adjacent to London may cover it, or

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cause it to be covered over, with buildings of any sort or size, and so covered as to leave nothing upon which the foot may be placed, except certain strips which as streets and alleys are necessary, as means of communication, to the application to profitable use of all the rest; and every possessor of available land does so. It is true that in "covering" the land small plots are here and there laid out as gardens, but this is done only when the sacrifice is more than made up by the greater rent obtainable for the building sites which front to such plots; for the gardens are inclosed, and are necessarily, and indeed properly, kept for the special use as pleasure-grounds of those who pay for the use in the rent of their houses, and in rates for maintaining them. These gardens are not for the use of the public, nor even for the occupiers of other parts of the same estate, which are laid out in streets, alleys, and mews; and except so far as such gardens are open spaces and pleasant to look at, their sites are, for the rest of the community, "covered." And thus the whole surface of every acre brought within the inhabited area of London is covered or otherwise occupied; and in such manner, as regards the community at large, as to render every garden and every field turned into building land worse than the land of Egypt was under the plague of locusts—for that plague was temporary—the land is darkened that one cannot see the earth.

But the land in and about London being devoted to the purposes of building, the legislature has provided that all buildings shall be inclosed with walls, and with unmitigable stringency, that all inclosing walls shall be built of brick or of stone, without any regard to the necessity or even the propriety of such an imposition in every case; and provision is made for securing the efficient separation of adjoining buildings, that each building may be protected from fire in the event of fire occurring in the next to it. But while the law is to some extent judicious in its provisions in that respect, it leaves builders at liberty to make each separate building dangerously susceptible of fire, and ready to burn; and so to a large extent London buildings are built and rebuilt. The legislature has, moreover, made some provision to check the narrowing of existing streets in London, by projections from and before buildings to that effect; but this has been rendered nugatory by an ill-advised and wilful controlling administration, and the abuse prevails. Nothing is imposed, however, in respect of the ventilation of buildings; and every building, whether for habitation or otherwise, and whether for occupation constantly as dwelling-houses and hospitals, or temporarily as churches, chapels, courts of judicature, theatres, or other places of public resort, which are all liable to be crowded, may be made as unfit for its purposes in respect of salubrity as the most ignorant or the most wrong-headed person engaged in building may choose or chance to make them; and so to a very large extent they are made; that is to say, without any rational provision for certain and wholesome ventilation. Not that London houses are left wholly unprovided with means by which air may gain access to their interiors, and both the law and necessity act together in most cases to insure the provision of such means. Costly sewers are built under the streets to receive and carry off to some outlet for discharge waste and cloacal waters; and as every building requires in a greater or less degree relief in respect of such matters, drain pipes are laid from most houses, as a matter of necessity, to such sewers, whereby a free passage is obtained for air from or by the common sewer to the interior of every house so connected with it. Air passing through such a duct into any house, cannot fail to take with it whatever volatile gases it may encounter in its course through the sewers, and the connecting or house drains; and there can, perhaps, be no doubt, that air so commingled will be more or less tainted. But the law not only permits such conduits to be established, but, by its administrators, causes holes, curiously designated *ventilating shafts*, to be made from the roadway of any street under which a sewer may pass, down into the sewer. These ventilating shafts are grated over, and when the gratings are not choked up with stones and mud, air and road stuff go down together by them into the sewers; that is to say, air goes down when there is a down draught, but in the absence of such a draught, faint but foul gases rise by the "ventilating shafts" to taint the air of the streets for the summer ventilation of the houses by their open windows. Down draughts prevail in winter time when fires are burning; for, windows being most reasonably kept shut when fire is required for warmth, and fires requiring air nevertheless, this requisite is commonly obtained by way of the house-drains from the sewers, and hence the down-draughts by the ventilating shafts; and from this cause it is, for the most part, that the air of the metropolis is at all seasons in a condition to induce fever. The foul air of its sewers and drains is either drawn into its habitations, or vomited into its streets.[1]

But London does not stand alone as to these matters. Sewers commissions and Boards of health are multiplied throughout the country, so that hardly any town of any importance in the British Islands can long remain without the control which such bodies bring with them; but neither the science nor the practice of these bodies, nor any combination of both, has yet devised and brought into operation any system by which towns may be at once purged of the filth and eased of the foul air, which arise as surely in human habitations as in rabbit-hutches and pig-sties; nor does it appear to have been ever imagined by the legislature, by whose authority such bodies act, that it is as necessary to health that every dwelling should be provided with (to use the cant term of the sanitary empirics) an unintermittent supply of fresh air, and means by which the spent air shall be certainly ejected, as it is to insist upon an unintermittent supply of water, and the ejection of that which had answered the ends of its introduction.

It is not enough to build sewers, even if every sewer have a proper discharge, while men may, in extending a town, form streets and erect buildings in such manner and at such levels that neither roads nor buildings can be relieved by means of any existing system of sewers, or by any sewer that can be made to lead to a proper and legitimate issue; nor is it enough to make a complete and efficient system of sewers, unless they are by legitimate means thoroughly ventilated; nor is it just to the community to allow house-drains to enter a common sewer unless such drains are first made free from the foul air which is a necessary consequence of their use; nor to the future occupiers of houses to allow the drains to be left by the builders in a condition to retain foul air; nor again ought any building to be capable of being used for any purpose involving occupation by human beings, unless there be that perfect ventilation as well as efficient drainage without which no building can be properly fit to live in.

The privilege of being a member of a civilized community is purchased by a concession, whether willingly or unwillingly made, of many natural rights; and the privilege of benefiting

[1] "In fact it [drainage] has become a science, and all manner of experiments, we read, are being made in it. Yet in spite of all our proficiency in the art, and of our many resources, it is acknowledged that nothing can be fouler than the sewerage of London; that through the gratings lately opened into them, in obedience to some law of science, there comes forth a most noisome and poisonous vapour; and that, melancholy to relate, five persons fell victims in one day, this year, to the pestilential breath of one of these scientific receptacles." (From "*Essays on Various Subjects*, by His Eminence Cardinal Wiseman." London, 1853.)

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by the industry and activity of the general community of which one is a member, ought not to be conceded without an equivalent to the community for the benefit obtained through and from it. The breath of heaven is the equal right of all; and it is the duty of society to itself, to take care that it comes unrestrained and untainted to all its members, so far as human means and appliances can do so consistently with the uses of human beings living in community. Society is bound, therefore, to insist upon every man conceding so much, at least, in respect not only of his house, but of every room in it, as shall be necessary both to secure to him his right as a human being in respect of wholesome air, and to prevent him from being a nuisance to the community of which he is a member, by condensing impurity within his dwelling, or doing anything else to vitiate the air of the locality. But it is of no use to provide means for the internal ventilation of dwellings, if buildings are so crowded together that they by their own mass prevent the due circulation of the outer air, and the change thereby in its condition which is essential to its wholesomeness; and it is a mockery of justice and propriety to call upon men to make sacrifices for what society fails to secure in return.

The right of human beings to move about upon the face of the earth which is given to man to occupy, cannot be exercised by him in a social state without restraint as to time and place. When man has, as he was commanded, subdued the earth, he is bound to limit himself for the common good to such use as may be consistent with the privilege of dominion; but he may not give up the means by which he lives to fulfil the ends of his creation; he cannot give up air, for without it he ceases to live, and he may not surrender the means of wholesome exercise, for without it he cannot have that without which life itself is a burden. When men congregate in communities, they are bound therefore—that is to say, society in the aggregate is bound—to provide not alone that the breath of heaven shall come unrestrainedly and untainted to all its members, but that the power to move about upon the face of the earth they occupy—to the extent, at the very least, of what is necessary to healthful exercise and recreation—shall be also fully retained. Human beings must not be so crowded together that they have not air, and wholesome air, to breathe, nor ought the habitations of human beings to be so crowded together that there is not space about or near to them for wholesome exercise.

But the rights of property interfere, and the owner of the land claims to dispose of the site in such manner as he may think most likely to conduce to his own interest. The owner of land, like the individual who is to occupy it to his profit, must make such concessions as it is the duty of society to require in permitting him to turn his land to profit in a manner affecting those conditions which are essential to the life and health of its members, whether present or prospective. The rights of property are to be observed, but the duties of property are to be performed; and if so under ordinary circumstances, how much the more under such circumstances as those herein contemplated. It is through and by the industry and activity of its inhabitants that a town requires extension; and as the land over which the extension may take place increases in value by the operation of such industry and activity,—and to a far greater extent than if the soil had been suddenly found to contain gold,[1]—it is the bounden duty of the legislature to take care, and by all reasonable imposition and restraint to provide, that the application of lands to such profitable account shall be made with due regard to the uses out of which the profit is to arise. The legislature is not justified in standing by until new interests have been created by the application of capital to the lands which environ a town, as they present themselves for absorption in it, and then to tax the community at large to buy up and clear off, at a huge expense, large plots here and there, at long distances apart, and from the centre. Plots of reasonable size, as hereinbefore set forth, ought to be claimed and retained as the duty of the property to the community whose industry and intelligence give such largely enhanced value to the rest, and as essential to the proper application of the rest to the purposes of a town.

If out of every 100 acres of land added to London within the present century alone, a tithe only had been claimed and set apart as a town garden, and maintained as such by a rate upon the inhabitants of the 90 acres distributed in streets and occupied by buildings, it would not have become necessary to obtain at an enormous outlay sites for recreation and exercise remote from the courts and alleys occupied by the labouring classes, and therefore practically useless to all but the few close at hand, as play-grounds for children, and places of resort for men and women who live by hard work, and who cannot afford carriages to convey them to Victoria Park or to Battersea Fields.[2]

For the same reason that as the community give enhanced value to lands as they become available for the increment of a town, the public may claim as a right, not only that such concession shall be made by the obtainer of the benefit as that last above indicated, but that the rest shall be so disposed, so prepared, and so occupied, as it regards streets and buildings, and that the buildings be so arranged, built, and relieved, as to secure the health, comfort, and safety of the future inhabitants; and it is to such effect that, as hereinbefore set forth, architecture, in its catholical sense, should be applied and enforced, by the authority of the British legislature on the part of the British public.

Section II.

The further explorations in Egypt, the discoveries in Asia Minor, the almost astounding exhumations in the valleys of the Tigris and Euphrates, the results of continued inquiries, by excavation and otherwise, in Greece, Italy, and other parts of Europe less fertile in historical antiquities, and the tracking out of remaining monuments of undescribed peoples in Central America, have tended greatly, by the illustrations obtained therefrom, to correct and improve, as well as to widen, our knowledge of the earlier history of the human race; of the condition of the mechanical and manufacturing arts; of some of the arts of design; and generally, to make us acquainted with a barbaric civilization to be always wondered at and sometimes admired. Among the remains of earlier and later antiquity thus within a recent period brought to light, there is much to confirm, and nothing to contradict, the theory propounded in the foregoing treatise of the origin of conventional architecture, or architecture in the narrower sense in which the term is there employed; but neither the rock caverns and temples of Egypt and India,

[1] Land in the neighbourhood of London, which, as grass land, has been let at from three to five guineas per acre, and the market value of which as such would not be more than from L.100 to L.170 per acre, rises gradually in selling value as the town grows out towards it, until it becomes building land, when its price is counted by thousands of pounds per acre, and that before a turf is turned.

[2] Even a wider view of the duties of property in land applied to the increment of towns may be taken and maintained. Having reference to the source of the increased value which the application of land to building purposes obtains for it, the disposal of the mortal remains of the human beings concentrated upon it by such application, should be provided out of the benefited estates—not by leaving it as a rate to be thrown upon the inhabitants, but by an appropriation of a sufficient part of the site, or an equivalent in money to buy a suitably removed site, to receive the remains of all the inhabitants which the building land may be capable of receiving when, in the course of nature, they must be removed to resting-places for the dead.

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nor the mounds of sun-dried bricks on either side of the Tigris, nor the addenda to our knowledge of Greek monumental antiquity supplied by the industry of Mr Penrose at Athens, and of Sir Charles Fellows in Lycia, nor the curious labours of Mrs Hamilton Gray and Mr Dennis in the mines of Etrurian antiquity, nor, indeed, the discoveries of Mr Stephens in Yucatan, add anything really available to the improvement of our knowledge of the constructive arts applicable to works of architecture, or to the design and decoration of such works.

But it may be of interest, nevertheless, to add to the statements contained and opinions advanced in the foregoing treatise as to the habitations of the earlier races of men within the historic period, the following observations of the distinguished labourer in the fields of Assyrian antiquity, to whose intelligence and activity the greatest discoveries above referred to are mainly due, and to inquire into the bearings of the recent discoveries upon the archæology of architecture. Mr Layard writes, in chap. xiii. of his *Popular Account of Nineveh*, page 341—"The earliest habitations, constructed when little progress had been made in the art of building, were probably but one story in height. In this respect the dwelling of the ruler scarcely differed from the meanest hut." And at page 348 of the same work, the author continues the same subject by the remark that "we have no means of ascertaining the nature of the private dwellings of the Assyrians, nor of learning any particulars concerning their internal economy and arrangement. No such houses have been preserved either in Assyria Proper or Babylonia, their complete disappearance being attributable to the perishable materials of which they were constructed; for although the palace-temples were of such extraordinary magnificence, the bulk of the people appear to have lodged, as in Egypt, and indeed in Greece and Rome, in very small and miserable dwellings, which, when once abandoned, soon fell to dust, leaving no trace behind." And having reference to the "palace-temples" laid open by himself in Assyria and Babylonia, Mr Layard remarks, in continuation of the paragraph first above quoted—"It soon became necessary, however, that the temples of the gods and the palaces of the kings, depositories at the same time of the national records, should be rendered more conspicuous than the humble edifices by which they were surrounded. The nature of the country also required that the castle, the place of refuge in times of danger, or the permanent residence of the garrison, should be raised above the city, so as to afford the best means of resistance to an enemy. As there were no natural eminences in the country, the inhabitants were compelled to construct artificial mounds. Hence the origin of those vast solid structures which have defied the hand of time, and, with their grass-covered summits and furrowed sides, rise like natural hills in the Assyrian plains." In further continuation of this part of the subject, the author writes at page 345 of the same work—"The mode of roofing the palaces and lighting the chambers, many of which were in the very centre of the building, with no other inlet for light but the door, is one of the most difficult questions in Assyrian architecture. I am inclined on the whole," Mr Layard writes, "to concur with Mr Fergusson [in his work entitled *The Palaces of Nineveh and Persepolis Restored*] in thinking that light was admitted through galleries or open rows of low pilasters above the alabaster slabs, and that wooden columns were sometimes used to support the roof in the larger halls. It is, however, remarkable that no remains whatever of columns have been discovered, nor are there any traces of them. Unless they were employed, the chambers exceeding a certain width must have been left open to the sky. There is no proof whatever of the rooms having been vaulted, although the Assyrians were well acquainted with the principle of the arch." And having regard to this last-quoted expression, it is necessary to extract the passage which appears to supply the evidence upon which the author may be supposed to rely in using it. This is found at page 266 of the same summary of his earlier but really less informing book, *Nineveh and its Remains*, in the following words:—"It only remains for me to mention a singular discovery on the eastern face of the mound [under one of the explored palaces or temples at Nineveh], near its northern extremity. A trench having been opened from the outer slope, the workmen came upon a small vaulted chamber, about ten feet high and the same in width, fifteen feet below the level of the mound, and in the centre of a wall of sun-dried bricks, nearly fifty feet thick. The arch was built of baked bricks. The chamber was filled with rubbish, the greater part of which was a kind of slag, and the bricks forming the vault and walls were almost vitrified, evidently from exposure to very intense heat. The chamber had thus the appearance of a large furnace for making glass or fusing metal. I am unable to account for its use," Mr Layard continues, "as there was no access to it, as far as I could ascertain, from any side."

Almost every explorer among remains of ancient times, in countries which possess works of high antiquity, but in which works the arch is not found to take its place in the structure, has referred to some example or other which has seemed to him to show that the properties of the arch were known to the builders, or to the people of the nation by whom the works were produced. Reports of examples of vaulted structure, found under circumstances which, like those last above quoted from Mr Layard, seem to assume the high antiquity of the work, have been received from time to time, with assurances derived therefrom that the properties of the arch were known to the people of the place at the time referred to;[1] but notwithstanding such reports, and the evidence adduced, be it real or fancied, the world will continue to deny that either Greeks or Egyptians, Hindoos or Assyrians, were "well acquainted with the principle of the arch," acquaintance with the principle being assumed to include a knowledge of the properties,—when they built, as we know from their grandest existing works they did build, without any exhibition of that acquaintance and that knowledge in their practice, under circumstances in which the arch would have been most certainly applied had its properties been known to the builders. There can indeed be no answer given to the assertion that "the Assyrians were well acquainted with the principle of the arch," more conclusively against it, than the statement by which it is preceded, that "there is no proof whatever of the rooms having been vaulted;" the circumstances of the case having been such, it would appear from the context and the illustrations, as admitted of vaulting. It is possible that a semi-civilized nation may have reached the wedge without attaining to the application of the properties of the inclined plane in a screw, or may have learnt to make the explosive compound known to us as gunpowder, and even to use it for blasting rocks, without attaining to the art of gunnery; but it seems unlikely that the more advanced nations of antiquity, who are not found to have employed the arch in the construction of works in which it would have been to them invaluable, could have been practically acquainted with its properties.

[1] Mrs Hamilton Gray must be excepted from the class of explorers referred to. With the good sense and clearness of perception that distinguishes most of her remarks on the many interesting matters which came under her observation among the remains of the old Etrurian cities, she observes with reference to the arch-shaped structure, known as the tomb of Regulini Galassi at Cæse or Agylla, "I call it a sort of arch, because it would seem to have been constructed before the regular arch was known, or its principles conceived." (*The Sepulchres of Etruria in* 1839, by Mrs Hamilton Gray, page 332.) See illustration on next page, fig. 1.

Most of the misleading examples which have been adduced to show that the properties of the arch were known to the earlier nations of the East, and in Egypt and Greece, have not exhibited even the constructive arrangement of the materials which is essential to an embodiment of the principle of the arch in vertical constructions. An aperture left in a wall to serve the purpose of a door or a window is required to be of limited height,—it is not to be permitted, indeed, to break the continuity of the wall throughout its whole height,—and it must, therefore, be stopped by a covering as a lintel in some efficient manner so that the wall may be carried on over it. The opening being too wide for a stone beam as a lintel to bear over, or a stone not being at hand of length and strength sufficient for the purpose, the courses are made to jut over the sides or jambs of the opening one above another by little and little until the gathering or corbelling over, as it is technically termed, has narrowed the space to be covered so much that the next course above completes the covering. The jutting ends of the stones will overhang, and this being thought unsightly, or found inconvenient, their lower angles are cut away, and the result is the outline in appearance of a pointed arch (See fig. 1), whence probably—as first suggested, it is believed, in the preceding treatise (v. *ante*, p. 446, 2d col.)—the form which was the germ of the pointed style. But the familiar form which at once induces the idea of an arch has misled many an untechnical observer into a belief that he has detected an arch where none has existed. It must be conceded, nevertheless, that the diagrams exhibited by Mr Layard in *Nineveh and its Remains*, his earlier work (published in 1849), and in the *Discoveries in the Ruins of Nineveh and Babylon, the result of a Second Expedition*, first published in the current year, 1853, and showing what are believed to be works of high antiquity, do present all the appearance of arch-built vaults.—See figs. 2, 3, and 4. Moreover, some of the sculptures removed by Mr Layard from his excavations among the Assyrian mounds of ruined palaces or temples, and now in the British Museum, present the appearances of door or gate ways in, or rather upon (for the sculptures referred to are in low relief only), city walls and the walls of buildings, having curved heads, as if they were arched over; but it is to be remarked that although there are frequent indications by lines on the same sculptured blocks, and in the same walls, of the joints of the horizontally-coursed masonry, there are no such lines, radiating or otherwise, above the bowed lines which would seem to present the form of arched heads to openings in the walls as doors or gates, to indicate joints in the masonry, and thereby to exhibit the structure of an arch.

Fig. 1.

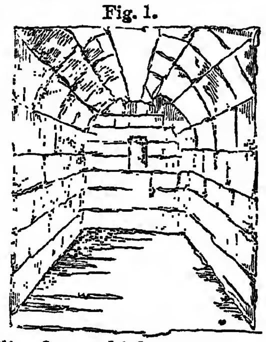


Fig. 2.

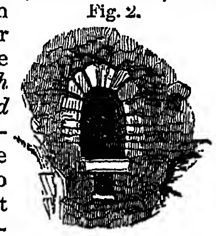


Fig. 3.

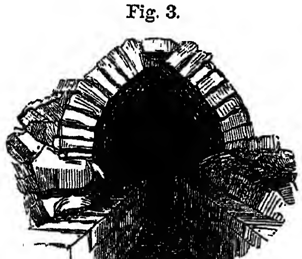
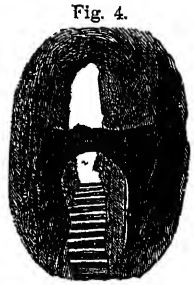


Fig. 4.



Reverting to the statement above quoted from the *Popular Account of Nineveh*, to the effect that no remains whatever of columns had been discovered, it is necessary to add the fuller paragraph from *Nineveh and its Remains*, from which it appears that it is not columns alone that are wanting in the Assyrian remains of the accustomed architectural display. Having described the wonderful works in sculpture which the mounds afforded, Mr Layard asks, at page 267 in vol. ii., "Were these magnificent mansions palaces or temples?" and observes, as in reply, and to show the absence of means of answering certainly, "Of the exterior architecture of these edifices no trace remains. I examined as carefully as I was able the sides of the great mound at Nimroud and of other ruins in Assyria, but there were no fragments of sculptured blocks, cornices, or other architectural ornaments to afford any clue to the nature of the façade." And so strikingly devoid is Assyria in its ancient remains of all such matters, that Mr Layard again, in his more recent work (Layard's *Discoveries in the Ruins of Nineveh and Babylon: being the result of a Second Expedition*. Lond. 1853), writes, at page 530, "We find no remains of columns at Babylon, as none have been found at Nineveh."

But Mr Layard has furnished the sufficient and conclusive reasons why columns and their accessories do not appear among the Assyrian remains. "The architecture of a people must naturally depend upon the materials afforded by the country, and upon the object of their buildings. The descriptions already given in the course of this work," *Popular Account*, "of the ruined edifices of ancient Assyria, are sufficient to show that they differed in many respects from those of any other nation with which we are acquainted. Had the Assyrians, so fertile in invention, so skilful in the arts, and so ambitious of great works, dwelt in a country as rich in stone as Egypt or India, it can scarcely be doubted that they would have equalled if not excelled the inhabitants of these countries in the magnitude of their pyramids, and in the magnificence of their rock temples and palaces. But their principal settlements were in the alluvial plains watered by the Tigris and Euphrates. On the banks of those great rivers, which spread fertility through the lands, and afford the means of easy and expeditious intercourse between distant provinces, they founded their first cities. On all sides they had vast plains unbroken by a single eminence until they approached the foot of the Armenian hills." (Pp. 340 and 341.)

Hence it is that the Assyrian ruins present no remains of columns and entablatures—the Assyrians had no stone but the tender and friable alabaster, which is capable of becoming almost plastic in the hands and for the purposes of the sculptor, as the Assyrian sculptures abundantly show; but which is wholly unfit for the purposes of the architect in his normal character of a constructor. Wanting stone out of which to form columns and architraves, the difficult question presents itself, as to the mode employed "of roofing the palaces and lighting the chambers." Mr Layard's opinion on this point, coinciding with that of Mr Fergusson, is given in the extract already quoted on the preceding page. "A mass of charred wood and charcoal," and "part of a beam in good preservation, apparently of mulberry wood, found near the southern entrance of the great hall" (*Popular Account*, p. 265), yield almost conclusive evidence that timber had been employed in the buildings for some purpose or other; and a woodcut at p. 252 of Mr Layard's more recent book already quoted, which contains the result of a second expedition, being further discoveries in the same countries, of a view of the interior of a modern house in the Sinjar, shows very clearly

how timber may have been employed in the formation and support of the roofs of the palaces or palace-temples of the ancient Assyrians, while the heavy sun-dried brick walls and piers may still form the outer lateral inclosure and supports of the building; that is to say, the flat roofs may have been, and probably were, structurally of timber, upborne by the outer walls of brick burnt or unburnt, aided intermediately by posts of timber and covered with bitumen.[1] Stability was given to the structure by the masses of sun-dried brick, and shelter for the inhabitants from the weather by the timbered flat coated with bitumen. But buildings so composed were both fragile and combustible; and fire taking the roofs, the walls and pillars fell into the heaps which Assyria and Babylonia have presented to the modern traveller.

It is most probable, too, that the Assyrian palace-temples, or whatever else they may be designated, were, for the purposes of light and air, hypæthral, and that the several halls presented each the arrangement, as it regards the admission of light and air, exemplified by the peristyled atrium of a Roman mansion, as shown by the Pompeian remains at the present day, and used as an illustration in Plate LXI. accompanying the preceding treatise.

Mr Fergusson, in the work referred to by Mr Layard, and in the frontispiece to Mr Layard's *Discoveries in the Ruins of Nineveh and Babylon, being the result of a Second Expedition*, and hereinbefore quoted, imagines combinations of timber for which the patent documents afford no sufficient authority, and which require greater skill in carpentry than the Assyrians and Babylonians are likely to have possessed. The wooden coffins of the Egyptians of the same time show us very plainly the state of the joiner's art among them; and a technically informed eye can readily determine the advance a people may have made in carpentry by the putting together of even a coffin, though that is a piece of joiner's work. It does not appear from any of Mr Layard's statements, as records of fact, that the beam found in the S.W. palace of Nineveh, or any other piece of timber discovered among the ancient remains in the countries which he has so well described, exhibited any of the operations of carpentry;—no indent as a mortise, and no projected end to a piece of timber as a tenon. It is true that the sculptured slabs of alabaster were kept in their places "as a kind of panelling to the walls of sun-dried bricks" (*Popular Account*, p. 343), "and held together by iron, copper, or wooden cramps in the form of double dove-tails." The dove-tail joint is found, though in a rude state, certainly, in the Egyptian coffins or mummy cases, of which such large numbers are open to public view in the British Museum; and so is the dowel found, used as a means of connecting boards one with another, by the face or by the edge, in the form of the pin-dowel, so familiarly known as the means by which the head of a cask is put together; and in the form of a tenon-dowel, which the Egyptians employed to attach the cover to the case, wooden pins giving the means of keying them. Pin-dowels are driven so as to set tight against the transverse section of the fibre, whilst a tenon-dowel requires to be held in the mortise by pins passing transversely through them. The coffins or cases of the earliest dates do thus present both mortise and tenon, as between board and board, with the fibres running parallel in each; but they do not present the mortise and tenon joints of carpentry, whereby timber may be framed; for which purpose the tenon must be formed on the end of one piece, of the substance of the piece, and be inserted at right angles for the most part into a mortise, being an indent of corresponding size and form in the substance of another piece; that is to say, the oldest coffins or cases do not exhibit framing, in the proper sense of the term, as a means of connecting timbers one with another; nor is the true mortise and tenon joint found in the large collection referred to, until the Greek or Ptolemaic period, when, and in the Roman period, the Egyptian coffins or mummy cases are found to be framed together as the rails are framed into the legs of a common table. Whilst existing remains of early Egyptian joiner's work show that the early Egyptians used the dove-tail and the dowel, and there is nothing to show that they knew the proper framing joint whereby alone timber may be efficiently put together to form a framed structure, we find no evidence upon which we can conclude, or may admit, that the Assyrians and the Babylonians were in advance of the Egyptians in that respect. We must therefore conclude that the timber structures suggested by Mr Fergusson, and adopted by Mr Layard in the frontispiece design of his books, which could not have been put together as safe structures without a system of framing and bracing beyond the skill in practice of the early Egyptians, could not have been carried out by their contemporaries in Mesopotamia. Nor does it appear, from anything discovered, that either Egyptians, Assyrians, or Babylonians had the means of making up for want of skill in carpentry, as the modern European and particularly English architects do make up for such want, by a profuse use of nails and screws, and of rods, bars, straps, and bolts of iron. The modern Yezidi houses in the Sinjar Mountains, above referred to as presenting local instances of timber structure, exhibit the timber in such manner as to show that even the modern Assyrian puts timber together as the ancient Egyptians did stone, and not by means of carpentry—relying upon mass, and the gravity that accompanies mass, even with the lighter body; but neither the one nor the other got by such means—whether with stone, brick, or timber—beyond one story high.

Our denial in the preceding treatise that the properties of the arch were known well enough at least to be appreciated by the more ancient nations of the East, including those of Egypt and Greece, until the arch had first become of general application in Italy, remains thus unimpeached by the recent discoveries in the valleys and plains of the Tigris and Euphrates; whilst in like manner our impeachment of the dendroid theory of the origin of those combinations of ancient works to which the designation architectural has been specially applied, receives negative confirmation from the results of Mr Layard's admirable labours.

To the foregoing observations it is to be added, that, although we have become possessed of no valuable addition to our previous stock of architectonic materials by the explorations in the Mesopotamian fields, the workings have brought to light much interesting documentary evidence, to the effect that the Greeks found the germ of their beautiful ornament, known to us as the honey-suckle, and so commonly used by them in the enrichment of their Ionic style, in Assyria. Mr Layard gives in the *Popular Account* (pp. 44, 45) the following interesting statement in connection with this subject:—"Adjoining this slab was a second, cut so as to form a corner, sculptured with an elegant device, in which curved branches, springing from a kind of scroll work, terminated in flowers of graceful form.........The flowers were

[1] "On the following day we passed the bitumen pits, or 'Kiyara,' as they are called by the Arabs. They cover a considerable extent of ground; the bitumen bubbling up in springs from crevices in the earth and forming small ponds. The Jebours and other tribes encamping near the place, carry the bitumen for sale to Mosul and other parts of the Paschalic. It is extensively used for building purposes, for coating the boats on the river, &c. . . . . Before leaving the pits, the Arabs, as is their habit, set fire to the bitumen." (*Popular Account*, c. xi. pp. 269, 270.)

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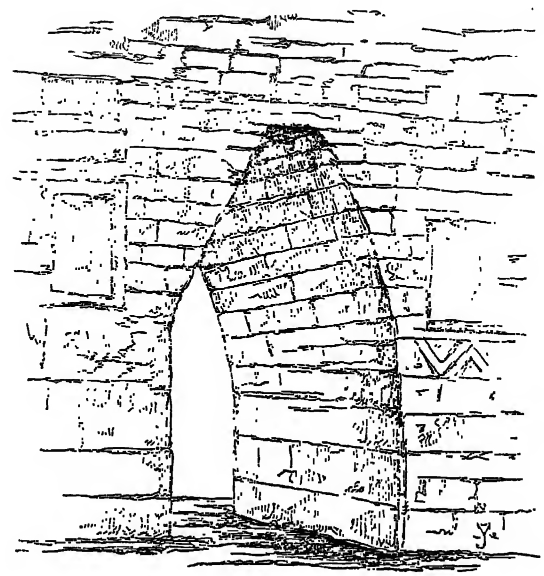
formed by seven petals springing from two tendrils, or a double scroll; thus, in all its details, resembling that tasteful ornament of Ionic architecture known as the honey-suckle. The alternation of this flower with an object resembling a tulip in the embroideries on the garments of the two winged figures, establishes beyond a doubt the origin of one of the most favourite and elegant embellishments of Greek art." Having regard to the sculptures referred to by Mr Layard, and to other evidence to the same effect, Mr Fergusson goes so far as to express an opinion—at page 340 of his ingenious speculations, under the title of *The Palaces of Persepolis and Nineveh Restored*—that "it is now impossible to doubt that *all that is Ionic in the arts of Greece is derived from the valleys of the Tigris and Euphrates.* But perhaps this opinion should receive the same qualification that would certainly be required for a declaration to the effect that all that is excellent in modern carpentry is derived from the Persian and Assyrian palaces, as exhibited in the preface to Mr Layard's book which contains the results of his second expedition; being a fanciful display of lofty and many-storied buildings, for the structure and disposition of the outer features of which Mr Layard's books contain no evidence.

It was not long before the exhumation by Mr Layard in Central Asia, of the wonderful remains of fine art in monstrous combinations of brute and human forms, entombed in earthen mounds, that Mr J. L. Stephens, when engaged on a mission from his government—that of the United States of North America—to some of the mutable states of Central America, heard of and tracked out in the forests of Yucatan[1] the remains of a bygone time exhibited in sculptural and architectural monuments of a coarse character, and revolting as regards the representations of human and bestial forms in sculpture, but not more revolting than the more elegantly designed and beautifully wrought works of the Central Asians; whilst the architectural remains afford a strange counterpart to those which Mr Layard describes, as he imagines them to have existed in and about the valleys of the Tigris and Euphrates. Huge mounds, constructed pyramid-wise and of stone, form in Yucatan the bases of the temples and shrines upon which some former inhabitants practised the horrid rites by which they thought the Almighty was to be worshipped; as in Assyria, there were mounds of the material the country afforded upon which the temples and shrines of an equally unholy worship was performed by the more graceful but most abominable sovereigns, subjects, and slaves of the Eastern tyrannies.

The graphic illustrations of Mr Stephens's records of his discoveries are by an English artist whose study had been especially architecture, and whose drawings may be taken, therefore, with more confidence to represent truly the forms and the disposition of the materials which the architectural remains of Yucatan present, than may be prudently yielded to the drawings of artists not so prepared. Mr Catherwood, the artist referred to, is known to have spent some of his earlier years in Egypt and the East, and he was thereby familiar with the ancient remains of those parts of the world; but it is not to be imagined therefore, that he drew upon his memory for the forms and dispositions of the materials of the American monuments. It is certain, however, that if the drawings Mr Catherwood has published of the architectural remains discovered in Yucatan, had been presented to the world as of remains found in hitherto unexplored parts of Nubia, or as existing in any part of Mesopotamia, or in the countries lying between Persia and the Tigris, they would have been taken to be prototypes of the more finished and more magnificent monuments so familiar to the world as the remains of the higher civilization of Egypt and the East.

Among the objects represented in Mr Catherwood's *Views of Ancient Monuments in Central America, Chiapas, and Yucatan*, are several examples of vaults having the arc form but not being arched vaults; that is to say, of vaults presenting the appearance internally, or upon the soffit, of arches, but formed by the gathering over of horizontally-coursed masonry, with the inner and lower angles worked away—or cleaned off, as it is technically expressed—to the appearance on the inside which an arched vault would present. See fig. 5.

Fig 5.



The circumstance that the arch form presented in the American monuments is produced by the gathering over of horizontally-ranged masonry, and not by means of arch structure, would seem to show clearly that if their builders ever had intercourse with the Old World, it was before the properties of the arch were known and practised in it. These remains show an advance on the Pelasgic and Celtic monuments of the cis-atlantic world, and take the general character of the stone works of Egypt and India; but like those works they exhibit the vaulted form by gathering over and not by arching.

Mr Catherwood states, at page 9 of the Introduction to the *Views*, that he and Mr Stephens concur in the opinion of Mr Prescott, the eminent author of the *History of the Conquest of Mexico*,—"that though the coincidences are sufficiently strong to authorize a belief that the civilization of Anahuac (Ancient Mexico) was in some degree influenced by Eastern Asia; yet the discrepancies are so great as to carry back the communication to a very remote period, so remote, that this foreign influence has been too feeble to interfere materially with the growth of what may be regarded, in its essential features, as a peculiar and indigenous civilization;" and this opinion the monuments, as presented by Mr Catherwood, would seem fully to justify. But Mr Catherwood adds to this, as the ground, it would appear, for coinciding with Mr Prescott's opinion, that the results arrived at by Mr Stephens and himself "are briefly, that they (the American monuments) are not of immemorial antiquity, the work of unknown men; but that, as we now see them, they

[1] Lord Kingsborough's great work on the *Antiquities of Mexico* contains, in some of the later volumes, representations of monuments which would almost appear to be the same as some of those subsequently explored by Mr Stephens.

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were occupied and probably erected by the Indian tribes in possession of the country at the time of the Spanish conquest, that they are the production of an indigenous school of art, adapted to the natural circumstances of the country, and to the civil and religious polity then prevailing; and that they present but very slight and accidental analogies with the works of any people or country in the old world." These results do not appear to accord with, but rather to controvert, the opinion expressed by Mr Prescott as above quoted; but neither the historian nor the explorer and his illustrator had at the time they respectively wrote the advantage of comparing the arrangements made alike by the ancient Assyrians and by the ancient Americans with one another, in respect of artificial high places upon which they respectively erected their temples, exhibited their monstrous idols, and performed their horrid rites, or they must have recognised the necessity, almost, of such results of a barbarian civilization having had a common origin. And having regard to this point, we refer to the paragraph in the preceding treatise (p. 438, 2d col.), where, by the aid of Humboldt, and without the light afforded by the discoveries of Layard in the East, and Stephens in the West, we had arrived at the conclusion to which a consideration of the evidence afforded by their labour has again brought us.

The researches of Sir Charles Fellows in Lycia have led to the discovery of some interesting monuments possessing architectural features which bear the Grecian impress; but they present nothing greatly valued by the practical architect of which he was not already in possession.

Mr Penrose has found, upon a more minute examination of the Parthenon than had perhaps been at any time before made of it, that its floor is slightly in rounding, to use the technical phrase, and that the entablatures are not in perfectly straight lines, or that they only appear to be straight and are not so; the supposed tendency of the eye to see crooked having been corrected in this particular case by the architect through the agency of the mason. If the noble ruin had not been exposed through long ages to quakings of the earth under it, and had not certainly been shaken by the explosion of a bomb shell within it, even the most minute aberrations from the line and the level in a work so carefully executed as the Parthenon was, might not be unreasonably attributed to design; and if the aberrations found to exist were intended, there may be reason to suppose that entasis was applied to the leading horizontal lines of the structure as a whole, as it certainly was to the outline of the columns, to convey to the eye the desired effect of truly straight lines. Mr Penrose has had the advantage of examining the remains of the Propylæum of the Acropolis without restraint, and he justifies the note by the late Mr W. Kinnaird in correction of Stewart and Revett, referred to in a note at page 462 *ante*. He points out also several other matters of interest to the student in the disposition of the parts of that structure. For some further details connected with this subject see ATHENS.

Mr John Pennethorne, who appears to have been the first to remark and call attention to the peculiarities in the Parthenon, which formed the main subject of Mr Penrose's examinations there, has subjected the forms and proportions of that monument to mathematical investigation; and Mr D. R. Hay has shown how the forms and proportions of the same structure may be educed from his ingenious system of geometric developments.[1]

Mere verbal reference to the many published delineations of existing works of date subsequent to the classical period, which is all that could be made in this place, would not convey any valuable information to the reader; but, indeed, there was very little to add to the amount of useful, and this is not the place for merely curious, information concerning them. The manner, of which the Constantinian Basilica is the type, so far as regards form and the disposition of the structure, is in some degree indicated by the front of Pisa Cathedral; though truly the style of design is almost as various as the examples. The buildings—for the most part churches—of the Constantinian period are commonly masked at the present time by an Italian exterior of the *cinquecento* style of design, whilst the more properly middle-age buildings are consistent throughout; but, as before remarked, the variety as to detail is great, though the leading characteristics continue much the same to and even through the true Gothic period of the northern nations, and until the introduction of the pointed arch. The terms Romanesque, Byzantine, and Lombardic, are now commonly, but uncertainly applied to the works referred to as antecedent to the Norman period; but the term Gothic is, nevertheless, generally applicable even to the Italian works of the middle ages, and most truly so to everything produced north of the Alps throughout the middle ages, and down to the time when the pointed arch gave a new character to construction as well as a new style.

Plate LXX.

The greatest of the Moorish remains in Granada have been made better known by the labours of the late able illustrator Mr Jules Goury, followed up by Mr Owen Jones in his well-sustained joint character of architectural draftsman and artist, but the more pretending ecclesiastical structures of Spain which purport to be in the pointed style have yet to receive similar attention. Cicognara continues to be the only trustworthy illustrator of that mine of beauty in architectural design, Venice; but his fine work is not easily obtained, and it is costly. Personal acquaintance with the works in the pointed style of Northern France, Flanders, and the Rhine, has led to a higher appreciation of the effect produced by magnitude and extent as exhibited in the greater churches, and to admiration of the choirs and chancels of some of them, and of the Belgian churches especially. Illustrations are to be found sufficiently indicative of the general characteristics of the manner of these works, but nothing short of personal knowledge can convey a true impression of their effect, while the peculiarities of construction can only be guessed at from merely pictorial illustrations.

At home correct delineations from actual admeasurement of our great works in the pointed style are more frequent than in any country abroad; for it continues to be true that the style is nowhere so well understood, so highly appreciated, or so much abused in applying it, as it is in the British Islands.

The old architectural wealth of Scotland has been recently made known beyond her own limits by the labours of Mr R. W. Billings, who being, like Mr Owen Jones, an architect as well as an artist, has known how to present the subjects so as to exhibit much of the structural character of the work in every case, as well as to give pictorial effect to his illustrations.

SECTION III.

No instance of sufficient mark and interest to be spoken of here has occurred within our knowledge, of the application, in modern practice and to modern purposes, of the mode and

[1] While the mathematician and the geometer have made the forms and proportions of the classical models of architecture their study, to discover and to determine the principles upon which they were established, so that by their application in modern practice, the excellent qualities of the antique examples might be obtained, the world of British architects have occupied themselves and amused the public with discussions upon some indications of plastering and painting which have been detected upon the surfaces of some of the architectural and sculptural remains of antiquity. The subject of discussion is designated Polychromy, and the taste which deems such trifling a matter of serious interest is distinguished by the term Æsthetic.

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style of composition peculiar to the structures, as they remain to us, of ancient Egypt—the earliest in date as in manner of any existing structures of high antiquity which display taste and refinement in their disposition and details—so as to make them worthy of study for any advantage derivable from such study; nor do instances present themselves of noticeable endeavours to apply the form presented by any ancient remains in Persia or in India; and we shall find, upon reference, that the now recent researches on this side of the last-named countries, have eliminated nothing likely to be of more interest and utility in practical architecture than the known remains of Egypt, Persia, and India, and already presented for the information of the inquirer and the study of the practitioner. The great western continent had already yielded up to the observation of the rest of the world many monuments interesting to the archæologist, but presenting nothing to distinguish them as works of taste or of mechanical skill, in which they are not far excelled by many remains of antiquity in the middle countries of the Old World.

The instances which present themselves on all sides of endeavours to adapt the columnar ordinances derived from the noble structures of ancient Greece are numerous; but it is to be added, that so far as regards the most noble and the most distinguished of the Grecian styles, every instance must be regarded as a failure. Even the Walhalla in Bavaria, which is understood to be professedly a reproduction, as to exterior form and distribution, of the Parthenon, is without the inner portico at one of its fronts—the opisthodomus is wanting. In what manner, or with what effect, the work is executed, the present writer has no personal knowledge; but at best the Walhalla is an exceptional case, and cannot be taken to be an adaptation of the Greek style to a modern purpose, but a copy, and an imperfect one, of a Greek temple. The interior of the Walhalla cannot be accepted as an embodiment of either Greek taste or structural propriety, whilst the rapid constructed approach from a low level to the elevated site of the building cannot fail to be injurious to the effect of its exterior, if it be only by taking the roof out of the view; but the graduated stylobate must also be intercepted and thereby lost to the view throughout much of the circuit.

The Grecian Ionic ordinance may be thought to have yielded in some degree to the requirements of modern uses; but having less of dignity to lose than the more purely Greek style—the Doric—and being exhibited in no ancient remains in such effective combinations as the Doric, modern compositions of which the Ionic ordinance forms the basis have the advantage over those which exhibit the Doric features of being tried by a less severe test. Nevertheless, the results, in the more prominent instances which London presents, of the application of the Grecian Ionic in modern structures do not tend to encourage the endeavour to mould this more plastic ordinance to modern purposes.

In compositions of less pretence, nearer approach may have been made to success in the application of the Greek Ionic ordinance. But the great defect of one in particular of the Athenian examples—that of the portico of Minerva Polias—of an inordinately wide intercolumination, whereby structural weakness is induced, is too commonly taken as an authority for such a disposition of the columns as that example presents, to the great detriment of most reproductions in modern instances of the Greek Ionic.

Corinthian, as an ordinance, is more Roman than Greek, and is much more plastic than the more purely Grecian ordinances; and being more plastic, it has been applied in modern practice and to modern purposes more extensively, and with greater success, than the less exacting, as it regards enrichment, but more exacting as it regards the circumstances under which they may be applied in practice, Doric and Ionic of the Greeks. It may be that the Corinthian column, being a more finished and acceptable object in itself than either the Doric or the Ionic column of whatever style, the eye exacts less, in respect of accessories and concomitants, from the Corinthian column than it does from the Doric and Ionic, which as columns are nothing; that is to say, they are unmeaning, and to some extent ungainly, objects, unless it be in appropriate composition, and with all the requisite accessories to complete the respective ordinances; whilst the Corinthian column, with its richly foliated and otherwise enriched capital, coped with a moulded abacus, and bound below by a moulded hypotrachelium, its fluted shaft and its moulded and enriched base, is itself an object to satisfy the eye, while the mind inquires less urgently for what purpose it is intended, and how it is to be disposed in composition.

However this may be, there can be no doubt, that whether the peculiar form in which the Corinthian ordinance presents itself be Greek or Roman—that is to say, whether the characteristics and details be those of the Greek example, or of a Roman example, to which the designation Corinthian is conventionally applied, or to that form of the foliated style which is by the Italo-Vitruvian school distinguished as the Composite order—it can be applied, whether in its full proportions, or shorn of some of its parts and details, with a success that has not attended the application of Doric and Ionic, in whatever guise.

But even the classical Corinthian ordinance is seldom found applied in modern works either at home or abroad, without sacrifice being made, in a greater or less degree, of the purposes of the work to the demands of the classical exemplar employed, or the more common sacrifice of the proportions found in the exemplar to the necessity of the case. Now the proportions found in the purer columnar architecture of Greece and Rome, of whatever style, are necessary results of the materials employed and of the mode of applying the materials in composition. The exemplars are all in stone of some kind or other, and the proportions and dispositions are such as the use of stone in legitimate structure of the sort applied would impose. Columns are placed as far apart as stone of the kind used in the case will bear over with certain safety in an architrave or lintel from column to column; such due proportion being observed between the horizontally disposed stone beam bearing over, and the vertically disposed stone column that has to support the superstructure, as the weight may require. Hence intercolumniation, or the space to be borne over, is not a matter of fancy, but of structural necessity; and the applicability of a classical columnar ordinance is structurally limited by the quality and character of the stone employed. Stone beams cannot be pieced out in length to bear over a void by any legitimate, or, what is commonly but expressively termed *workmanlike* manner; and arched structure is inadmissible in a pure columnar composition, as arches of whatever form require to be buttressed; and the essence of a columnar ordinance as a structure is in the weights being applied to act upon the column in that direction only in which the column is qualified to bear pressure; that is to say, vertically, or in the direction of its vertical axis. Marble will bear both transverse strain and vertical pressure better than freestone, and granite better than marble; and hence it is that the several parts of columnar ordinances in the works of the Greeks are more massive in their proportions when freestone is used, and lighter in the examples in which marble is employed; and the same relation will be found to exist between heavy and light proportions in the Egyptian temples. It is not according to their respective dates, but according to the material employed in the structure, that the proportions of the parts to each other are heavier or lighter,—the structure is more condensed or more drawn out as sandstone or porphyry is the constituent material of the building. It is the same with the better

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works of the Roman period; that is to say, in the composition of the columnar ordinances of their sacred structures; and the Romans indulged in the use of almost every kind of stone available for the purpose in the columnar ordinances applied to their temples.

Thus out of truth in structure, having reference to the material employed, grew the forms and proportions found in the classical exemplars of columnar architecture, stone being the material of the structures, and the capability of the stone to bear and to bear over giving the limit to the columns, and to the parts required to bear over, and thereby prescribing the proportions of the parts to each other, and to the spaces between the bearing parts. To falsehood in structure are attributable the failures to reproduce in modern compositions the admirable effects found in the columnar ordinances of the Greeks and Romans in which truth prevailed. Proportions permitted by marble are repeated in tender freestone, and this failing, foreign substances and unworkmanlike tricks of handicraft are applied to cheat the sense; but the eye refuses to be deceived, even if the structure endure. There may be sufficient strength in reality, for the effective material employed may be timber or iron, or other substances capable of yielding the required result in strength with far slighter proportions than stone of any kind truthfully applied will permit; but a tutored eye will detect the weakness in effect; and not unfrequently the trick is exposed to the common observer by some failure in the means adopted in the case.

The entablature of the central bay of the lower pseudo-prostyle of the west front of St Paul's in London, reaching from column to column, over a disproportionately wide intercolumniation, exhibits a well-marked instance of the failure of the false structure whereby it was endeavoured to cheat the eye. The architrave is in three stones; that is to say, the architrave stones bearing on the adjacent columns are pieced out by a third stone, which having no true structural connection with them, the middle length has torn itself away from its illegitimate attachments, and the stone above it in the frieze is broken across; or it may be, indeed, that the suspended block in the architrave was hung up to the frieze course; but be that as it may, there it is a striking example of undue proportions exhibiting themselves in the failure of the means by which they were obtained.

Structural untruth is not to be justified by authority. Neither Sir Christopher Wren, nor the Athenian exemplars of Doric and Ionic in the Propylæum, and in the Minerva Polias, with their irregular and inordinately wide intercolumniation, can persuade even the untutored eye to accept weakness for strength, or what is false for truth. Probably no eye ever regarded the middle bay of the Propylæum with satisfaction after having looked upon the Parthenon; and certainly none could turn with pleasure from the well and truly proportioned disposition of the columns of the Erechtheum prostyle to the straggling columns of the adjacent portico of Minerva Polias.

This doctrine may be supposed to preclude the use as models of the classical exemplars in architecture of the most tasteful nations of antiquity, unless reproductions be made of the materials as well as in the manner of the antique exemplar. But this no more follows than that a man who cannot afford to possess himself of sculptures in marble shall not accept casts; the architect is not precluded from applying the truth and beauty of form and proportion found in the classical examples in consistent composition, in any fitting material proper to the purpose of the work. Mr Welby Pugin did not hesitate to employ brick-work in the face as well as in the heart of the work, in building the Romish church known as St George's, Southwark, though the great exemplars of the style he employed are of stone; but he modified the proportions to the material, and produced a truthful and in many respects an admirable work.

To do this or that, however, merely because this or that is found in canonized examples of a period or of periods in which works of high merit and great beauty were produced, is not less preposterous than it is to endeavour to apply the classical columnar ordinance, and to pay no regard, in doing so, to the principles upon which their beauties are founded. And the same observation applies alike to every style of architectural composition.

Out of truth in structure, and that structure of a very inartificial sort, grew the beautiful forms of the admirable proportions found in the works of the Greeks, and out of truth in structure, with the strictest regard to the necessities of the composition and to the materials employed—and that structure of a sort as full of artifice as the artifice employed is of truth and simplicity—grew the classical works vulgarly called Gothic, but more characteristically designated Pointed, from the form of the arch which is the basis of the style. But the classical columnar degenerated into the Italian of the *cinquecento*, in which columns and their accessories are constructed as ornaments, and are no part of the structure as such with which they are mixed up, or to which they are affixed; and the classical Pointed fell into desuetude, or was found only in a debased connection with the Italian—picturesque at times, but more commonly grotesque, and never with any claims to decent bearing.

Truly, however, the purposes of modern life are not fully answered by either of the grand and ruling styles—the classical columnar of the Greeks and Romans, and the classical Gothic or Pointed. They both had their birth in those frailties of man which lead him through devotion to superstition, and in structures intended for the worship of the unknown God, the noblest results of both styles were and still are exhibited;[1] and neither the classical columnar, nor the classical pointed bends itself, or allows itself to be bent to secular purposes without loss of both truth and beauty.

Doubtless there is much to admire in many of the productions of the Italian school of architecture, from the *cinquecento* period down to the present time; and many recent works in the pointed style, and some in the mongrel manner that arose out of its debasement in connection with the Italian, exhibit, if not originality, at the least careful copying.[2] Copying, with an affectation of originality, indeed, is carried to such an excess in modern English practice, that mere monstrosities are sought out to be copied. Wearied with building spires upon the towers of churches of such reasonable proportions that they may at once please the eye and be safe as structures, recent practice has set up

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[1] It is a remarkable fact, indeed, that the greatest excellence in architecture has been obtained in connection with the grossest errors in theology. Witness Egypt, Greece, and Rome.

[2] Mere copying, and the most servile copying, is the ruling vice of the day, and it cannot be denounced in more eloquent language, or in more just terms, than it has been done in the following passage by an eminent person, a distinguished member of his sect in England:—"We have almost canonized defects, and sanctified monstrosities. What was the result of ignorance or unskilfulness, we attribute to some mysterious influence or deep design. A few terms give sanction and authority to any outrageousness in form, anatomy, or position; to stiffness, hardness, meagreness, unexpressiveness—nay, to impossibilities in the present structure of the human frame. Feet twisted round, fingers in wrong order on the hand, heads inverted on their shoulders, distorted features, squinting eyes, grotesque postures, bodies stretched out as if taken from the rack, enormously elongated extremities, grimness of features, fierceness of expression, and an atrocious contradiction to the anatomical structure of man,—where this is displayed,—are not only allowed to pass current, but are published in the transactions of societies, are copied into stained glass, images, and prints, and are called 'mystical,' or 'symbolical,'

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in London and its vicinity several offensively acute, and dangerously poised erections, as spires. Monstrous dwarf towers, having the appearance of wind-mills without arms, almost alternate with the feeble spires, and, consistently enough, the natural order is commonly reversed in placing these things; towers are set up in the plain, and spires are erected on the hills.

The works of living men may not be dealt with unless it be to praise them; and thus there are but few recent works in London, or elsewhere, within the personal knowledge of the present writer, which can be referred to in this place in illustration of the practice of the day.

London is indebted to Sir Charles Barry for an admirable example of the better kind of Italian street architecture in the Travellers' Club House, which shows how much of beauty may be obtained by just proportions, tasteful disposition, and unpretending decoration. The north or Pall Mall front would seem to be the result of a study of the Pandolfini Palace at Florence, to which it is fully equal in merit; but the south or Carlton Gardens front, which is in the manner of the Venetian school of design, is really beautiful, and as far excels anything else hitherto produced by the same architect as his works in Pall Mall excel all others in that street of great pretence. The Reform Club House exhibits the general features of the principal front of the Farnese Palace at Rome; but the proportions of the upper story particularly of that great work are not obtained, and the grandeur of the original is not fully attained, whilst the recent work is overpowered by the noble and fitting crowning cornice of the model. These sister buildings, standing side by side, deal hardly with one another, because of the great difference between them in height and magnitude; but each being made complete in elevation by the exhibition of its roof as a part of the composition, not only bears the presence of the other without suffering from it, but, together, they show by contrast the beauty of propriety in the exhibition of a fitly covering roof in contrast with the pavilion parapet so commonly exhibited as a mask to, or rather as an apology for, a roof. The plans of the Travellers' and the Reform Club Houses are also well devised, and are of great merit.

Plate LXVI., fig. 3.

The effect of the Travellers' Club House upon recent productions throughout the country has been great and beneficial, for the style of design which it presents is now often applied with good taste and proper feeling, though few practitioners seem to understand fully how they are to manage the roof so as to do without a parapet; or rather, perhaps, the parapet, in some form or other, has been so long looked upon as an essential, that few know how to do without it. They must have columns, too, upon their fronts, without knowing how to apply them inoffensively, as Vignola applied them in his beautiful Villa Giulia; and as Mr Cockerell has done in his beautiful elevation of the Sun Fire Office, at the corner of Threadneedle Street and Bartholomew Lane in London.

Plate LXVI., fig. 2.

In a small church at East Charlton, near the western boundary of Woolwich, Mr Gwilt has shown how much of good effect as well as useful service may be obtained with great economy in the application of the Italian style of design, in its earlier and simpler form, to ecclesiastical purposes. At Streatham, another suburb of London, there is a church in the Lombardic manner, by Mr Wild, also of plain and simple character, but the manner is not capable of any very agreeable effect.

The Romish church in St George's Field, Southwark, designed by the late Mr Welby Pugin, is, without doubt, the most truthful composition in the pointed style of the time; and out of truth in composition and perfect simplicity has arisen that quiet beauty which is so seldom found in modern compositions affecting that style; but as the tower is not wholly built up, and consequently the spire (as one must have been intended) remains unbuilt, the work is wanting in completeness, and consequently in the effect which, as a whole, it would be likely to produce.

An endeavour, and not unsuccessful, to vary the monotony too commonly prevailing in the streets of London, has been made by Mr T. H. Lewis, in erecting a building on the east side of Leicester Square, for purposes similar to those of the well-known Polytechnic Institution. The Panopticon purports to be studied upon the style of design prevalent in the capital of modern Egypt, presenting to a large extent flat surfaces, or surfaces diversified by slightly profiled proportions. The whole elevation is enriched by coloured materials disposed for pleasing effect, and the effect produced is very striking, and far from unpleasing.

A house has been recently erected in London in the style of design prevalent in the streets of Paris; under a misapprehension, it may be thought, that an arrangement which is found to be pleasingly effective in the narrow streets of that city must necessarily be productive of a similar effect upon the verge of a park.

Much might be said without offence of the extensive works in architecture of novel character, erected for railway stations, and in connection with them; but they are for the most part of so fleeting a character that, judging from the past, most of what exists now in the autumn of 1853, may have fallen down, or have been pulled down, to make way for something else before the autumn of 1854.

In treating of the practice of architecture, the practice of architects must not be wholly passed over.

There are in London two associations, claiming somewhat of a national character, of persons practising in, and in connection with, architecture;—one the Institution of Civil Engineers, and the other the Royal Institute of British Architects.

The Institution of Civil Engineers was founded in 1817, "for facilitating the acquirement of professional knowledge and for promoting mechanical philosophy." This body contains many of the ablest and most ingenious constructors and mechanicians of our country.

The Transactions of the Institution of Civil Engineers are voluminous, and they contain much valuable matter in fulfilment of the declared objects of the institution.

The Institute of British Architects was founded about the year 1835, "for facilitating the acquirement of architectural knowledge, for the promotion of the different branches of science connected with it, and for establishing an uniformity and respectability of practice in the profession." This body numbers among its members most of the artist architects of the day. It has published two half volumes of transactions, in which there are some fine graphic illustrations, and useful practical observations. (W. H—G.)

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or 'conventional' forms and representations. And this is enough to get things praised and admired, which can barely be tolerated by allowance for the rudeness of their own age. We have seen representations of saints such as we honestly declare we should be sorry to meet in flesh and blood, with the reality of their emblematic sword or club about them, on the highway at evening. And because these were the productions of an *age* eminently Catholic, they are considered as the types of an *art* equally so. But religious art does not look at time, but at nature, which changes not, and at religion, which is equally immutable. To make rude carvings, because the building on which they are placed is Norman, or to make a stiff design because the glass is framed in early English tracery, may be all quite characteristic, but it is not artistic. The object of all art is to speak to the eye, and, through it, to the feelings; and the object of religious art is consequently to excite, through the sight, religious emotions, adequate to the subjects or persons represented."—Cardinal Wiseman's *Essays on Various Subjects*.

GLOSSARY OF NAMES AND TERMS USED IN ARCHITECTURE.[1]

ABACISCUS (diminutive of Abacus, *q. v.*) This term is applied to the chequers or squares of a tessellated pavement.

ABACUS (Gr. αβαξ, a square tile or table). The rectangular and equilateral tablet covering the ovalo of the capital of the Doric column, and on which the superimposed entablature rests, is called the abacus; and from it the similar part (though differently shaped) of all capitals is distinguished by the same term. Abacus means the same thing, but is opposed in application to PLINTH, *q. v.* See also Plate LXII. fig. 1.

ACROTERIUM (Gr. ακρωτηριον, the summit or vertex), a statue or ornament of any kind placed on the apex of a pediment. The term is often incorrectly restricted to the plinth, which forms the podium merely for the acroterium. The statue of the saint on the apex of the pediment of the western front of St Paul's is an acroterium; the other statues may be called acroteral figures.

AMPHIPROSTYLE (Gr. αμφι, around or about, and *prostyle*, *q. v.*) A temple with a portico at each end is said to be amphiprostylar. This term would be more correctly applied to a structure having projecting porticoes on all its sides, especially if it be equilateral like the *Bourse* or Exchange at Paris, allowing no distinction of flanks or wings to make it peripteral. See Plate LV. fig. 3 and 4.

ANNULET (Lat. *annulus*, a ring). This term is applied to the small fillets or bands which encircle the lower part of the Doric capital immediately above the neck or trachelium.

ANTÆ (probably from the Gr. αντιος, or some other derivative of the preposition αντι, for, or opposite to; it has no singular), the pier-formed ends of the walls of a building as in the portico of a Greek temple. A portico is said to be *in antis* when columns stand between antæ, as in the temple of Theseus, supposing the peristyle or surrounding columns removed. Plate LIV., fig. 1, 2, and 3.

ANTEFIXÆ (Lat. *ante*, before, and *fixus*, fixed), upright blocks with an ornamented face placed at regular intervals on a cornice. Antefixæ were originally adapted to close and hide the lower ends of the joints of the covering tiles on the roof of a temple as they appear in the examples. Plate LIII. fig. 1, 2, and 4; and Plate LV. fig. 3.

APOPHYGE (Gr. αποφυγη, a flying off), the lowest part of the shaft of an Ionic or Corinthian column, or the highest member of its base if the column be considered as a whole. The apophyge is the inverted cavetto or concave sweep, on the upper edge of which the diminishing shaft rests. Plate LXII. fig. 1.

APTERAL (Gr. α priv. and πτερον, a wing), a temple without columns on the flanks or sides. The Greek Ionic temple, Plate LV., is apteral.

ARÆOSTYLE (Gr. αραιος, rare or weak, and στυλος, a column), a wide intercolumniation. (See EUSTYLE.) The space assigned to this term is four diameters.

ARÆOSYSTYLE (compounded of *aræostyle* and *systyle*, *q. v.*) This term is used to express the arrangement attendant on coupled columns, as in the western front of St Paul's Cathedral. Plate LXIV. fig. 1.

ARCADE, a series of arches.

ARCH (Lat. *arcus*, a bow), a construction of separate or distinct blocks or masses of any hard material, cut wedgewise, and arranged in a bowed form, so as to bear from end to end horizontally, or across an opening, though abutting or being supported only at the ends.

ARCHITRAVE (Gr. αρχη, chief, and Lat. *trabs*, a beam), the chief beam,—that part of the entablature which rests immediately on the heads of the columns, and is surmounted by the frieze; it is also called the epistylium or epistyle. Plate LXII. fig. 1. The moulded enrichment on the sides and head of a door or window is called an architrave.

ARCHIVOLT. This term is a contraction of the Italian *architrave voltato*. It is applied to the architrave moulding on the face of an arch, and following its contour.

ARRIS, the sharp edge or angle in which two sides or surfaces meet.

ASTRAGAL (Gr. αστραγαλος, a vertebral joint), a convex moulding. This term is generally applied to small mouldings, and torus to large ones of the same form. See TORUS.

ATTIC, a low story above an entablature, or above a cornice which limits the height of the main part of an elevation. The etymology of this term is unsettled; probably the upper range of columns in a Greek hypæthral temple (see Plate LIII. fig. 1.; and see also *Archæologia*, vol. xxiii. p. 412), was called ατειχον or ατοιχον, from having no coherent wall; whence the Latin *atticum*, and its application to a story superimposing the general ordinance. Otherwise such a thing is unknown in Greek architecture; but it is very common in both Roman and Italian practice. What is here termed the tholobate in St Peter's and St Paul's Cathedrals are generally termed attics.

BALUSTER, a small column or pier supporting the coping in a pierced parapet: the parapet itself when pierced is hence called a balustrade.

BAND or TÆNIA, nearly synonymous with Fillet, *q. v.* This term is, however, most generally applied to that listel in the Doric entablature which separates the frieze from the architrave, and connects the lower parts of the triglyphs.

BASE (Gr. βασις). The congeries of mouldings generally placed under the shaft of an Ionic or Corinthian column is called its base. Plate LXII. fig. 1. The term is applied also to the lowest part of a pedestal or stylobate; to the vertical moulded fittings which go round walls on the floor; and generally to everything that is put lowest, for anything to rest on.

BASEMENT. A basement story is a story in any building placed below the level of the ground on the outside of and about the building. Basement applied specially, as architects apply it, means the compartment in the elevation of a building upon which any columnar pilastraded or arcaded ordinance may rest; as in the Strand front of Somerset House, of which the basement begins at the level of the floor of the vestibule, being about that of the street pavement, and extends upwards to half the height of the adjoining building east and west.

BATTER (Fr. *battre*, to beat). Building over in projecting courses, like inverted steps, is termed battering, gathering, or corbelling over. The term is often applied to the converse operation of throwing back, as in a revetement or retaining wall.

† BATTLEMENT, a pierced or machicolated parapet.

† BAY. The space between the mullions of a window, between piers, and between the principal beams of a roof, floor, or ceiling, is a bay. The term Bay is also applied to a projected window or compartment of windows which forms on the inside a bay. Such a compartment in a shop is vulgarly called a Bow-window.

BEAD, a small cylindrical moulding of frequent use. Plate LV.

[1] Those marked thus † are either entirely, or almost entirely, peculiar to Pointed Architecture.

BED-MOULD the congeries of mouldings which is under the projecting part of almost every cornice, and of which indeed it is a part. Plate LXII. fig. 1.

BELL, is a term applied to the solid cove of a Corinthian or other foliated capital to a column, being, indeed, the basket of the pretty Vitruvian fable of the invention of the Corinthian capital.

BLOCKING-COURSE, a deep but slightly projecting course in an elevation, to act as cornice to an arcade, or to separate a basement from a superior story. (See STRING-COURSE.)

† BOSS, a sculptured knob which is placed on the intersections of ribs in groined ceilings.

† BUTTRESS, the projected piers against the quoins of towers, and against the ordinary piers of walls, to strengthen them, and receive the outward thrust of the inner transverse arches.

CABLING. The flutes of columns are said to be cabled when they are partly occupied by solid convex masses, or appear to be refilled with cylinders after they had been formed.

† CANOPY, a covering or hood, the enriched projecting head to a niche or tabernacle. The tablet or drip-stone, whether straight or circular, over the heads of doors or windows, if enriched, is called a canopy.

CAPITAL, CAP (Lat. Caput, the head), the spreading, moulded, voluted, foliated, or otherwise enriched head of a column. Plate LXII. fig. 1. The term *cap* is applied, in contradistinction, to the congeries of mouldings which forms the head of a pier or pilaster.

CARYATIDES. Human female figures used as piers, columns, or supports, are called *Caryatides;* and, adjectively, *Caryatic* is applied to the human figure generally, when used in the manner of Caryatides. Plate LVI. fig. 4 and 6.

CASSOON (Ital.), a deep panel or coffer in a soffit or ceiling. This term is often written, after the French, *caisson*, whereas we derive it directly from the Italian *cassone*, the augmentative of *cassa*, a chest or coffer.

CATHETUS (Gr. καθετος, a perpendicular line). The eye of the volute is so termed because its position is determined, in an Ionic or voluted capital, by a line let down from the point in which the volute generates.

CAULICULUS (Lat. a stalk or stem), the inner scrolls or tendrils of the Corinthian capital are called *Cauliculi.* It is not uncommon, however, to apply this term to the larger scrolls or volutes of the same also. Plate LXII. fig. 1.

CAVETTO (Ital. *cavare*, to dig out), a moulding whose form is a simple concave, and impending. Plate LVII.

CELLA (Lat.), the cell or interior of a Cleithral temple. The Greek term is Naos, *q. v.*

CHAMFER. An edge or arris taken off equally on the two sides which form it, leaves what is called a *chamfer.* or a *chamfered edge.* If the arris be taken off more on one side than the other, it is said to be splayed or bevelled.

† CINQUEFOIL, tracery in five foliations or featherings. The windows in the towers of Westminster Hall, Plate LXXI., are cinquefoiled.

CLEITHRAL (*vide* CLEITHROS). This is used of a covered Greek temple, in contradistinction to *Hypæthral*, which designates one that is uncovered.

CLEITHROS (Gr. κλειθρος, an inclosed or shut-up place). A temple whose roof completely covers or incloses it is a Cleithros. Plate LIV. fig. 1, 2, 3; and Plate LV. fig. 1 2, 3, and 4.

COFFER, a deep panel in a ceiling.

COLUMN (Lat. *columna*), a tapering cylindrical mass, placed vertically on a level stylobate, in some cases with a spreading congeries of mouldings called a base, and having always at its upper and smaller end a dilating mass called a capital. Columns are either insulated or attached. They are said to be attached or engaged when they form part of a wall, projecting one half or more, but not the whole of their substance. Plate LV. fig. 1 exhibits insulated and fig. 2 attached columns. See also Plate LXII. fig. 1.

CONSOL or CONSOLE, a bracket or truss, generally with scrolls, or volutes, at the two ends, of unequal size and contrasted, but connected by a flowing line from the back of the upper one to the inner convolving face of the lower.

COPING, the covering course or cornice of a wall or parapet. The term *coping* is generally applied to a plain, slightly projected, covering course, and *cornice* to a larger moulded coping.

† CORBEL, a knob, boss, or consol, projecting from a vertical face, to act as a prop or support. Its jutting or overhanging has induced the application of the term to describe the projecting of one thing over another.

CORNICE (Gr. κορωνις, the highest part, that which is placed last on a building), the highest part of an entablature—that which rests on the frieze. Plate LXII. fig. 1. The term *cornice* is very generally applied to any bold congeries of mouldings occupying the highest place in a composition, whether external or internal. A plain covering to a wall or parapet is called a coping, *q. v.*

CORONA (*vide* CORNICE). This term is applied to the deep vertical face of the projected part of the cornice between the bed-mould and the covering mouldings. Plate LXII. fig. 1.

COVE—COVING. The moulding called the cavetto,—or the Scotia inverted,—on a large scale, and not as one of a mere moulding in the composition of a cornice, is called a cove or a coving.

† CROCKET (probably from the old English word *crok*, a curl), an ornament of foliage or animals running up the back of a pediment, arch, pinnacle, or spire, from the corbets below to the finial above, in which latter the crockets on both sides appear to merge. Plate LXXI. fig. 3 and 5. In the earlier examples the crocket is a mere curl, or bent tendril, with an enriched end.

CUPOLA (Ital. *cupo*, concave, profound), a spherical or spheroidal covering to a building, or to any part of it. Plate LX. fig. 2, 3, and 4; Plate LXV.; and Plate LXX. fig. 2.

† CUSP (Lat. *cuspis*, a spear), the points in which the foliations of tracery finish. These are sometimes themselves enriched, and are sometimes plain.

CYCLOSTYLE (Gr. κυκλος, a circle, and στυλος, a column). A structure composed of a circular range of columns without a core is cyclostylar; for with a core the range would be a peristyle. This is the species of edifice falsely called by Vitruvius Monopteral. (See MONOPTEROS.)

CYMA (Gr. κυμα, a wave), the name of a moulding of very frequent use. It is a simple, waved line, concave at one end and convex at the other, like an Italic *f.* In that manner it is called a cyma-recta; but if the convexity appear above, and the concavity below on the right hand, it is then a cyma-reversa. Plate LVII.

CYMATIUM. When the crowning moulding of an entablature is of the cyma form, it is termed the Cymatium.

CYRTO-PROSTYLE. An alternation of Cyrtostyle (*q. v.*), but indicating more clearly than Cyrtostyle does an external projection.

CYRTOSTYLE (Gr. κυρτος, convex, and στυλος, a column), a circular projecting portico. Such are those of the transept entrances to St Paul's Cathedral, Plate LXV. fig. 1.

DADO or DIE, the vertical face of an insulated pedestal between the base and cornice or surbase. It is extended also to the similar part of all stereobates which are arranged like pedestals in Roman and Italian architecture.

DECASTYLE (Gr. δεκα, ten, and στυλος, a column), a portico of ten columns in front. (See note to the term HEXASTYLE.) The portico to University College, London, is

of this description; more particularly described, it is decaprostyle and recessed.

DENTIL (Lat. *dens*, a tooth). The cogged or toothed member, so common in the bed-mould of a Corinthian entablature, is said to be dentilled; and each cog or tooth is called a dentil. Plate LXII. fig. 1.

DESIGN. Architects apply this term to what is vulgarly called a plan, intending by it the scheme or design of a building in all its parts, the term *plan* having a distinct application to a technical portion of the design. (See PLAN.) The plans, elevations, sections, and whatever other drawings may be necessary for an edifice, exhibit the design.

DETAIL. As used by architects, detail means the smaller parts into which a composition may be divided. It is applied generally to mouldings and other enrichments, and again to their minutiæ.

DIAMETER (superior and inferior). The greater diameter of the shaft of a column is technically termed its inferior, because it is that of the lower end; and the lesser, that of the upper end, its superior diameter.

DIASTYLE (Gr. δια, through, and στυλος, a column), a spacious intercolumniation, to which three diameters are assigned. (See EUSTYLE.)

DIPTERAL. (See DIPTEROS.)

DIPTEROS (Gr. δις, twice, and πτερον, a wing), a double-winged temple. The Greeks are said to have constructed temples with two ranges of columns all round, which were called dipteroi. A portico projecting two columns and their interspaces is of dipteral or pseudo-dipteral arrangement. See description of fig. 3, Plate LIV.

DISTYLE (Gr. δις, twice, and στυλος, a column), a portico of two columns. This term is not generally applied to the mere porch with two columns, but to describe a portico with two columns in antis. The elevation of the pronaos of the hexastyle peripteral temple, Plate LIV. fig. 2, exhibits an example of distyle *in antis*.

DITRIGLYPH (Gr. δις, twice, and triglyph, *q. v.*), an intercolumniation in the Doric order, of two triglyphs. (See MONOTRIGLYPH.)

DODECASTYLE (Gr. δωδεκα, twelve, and στυλος, a column), a portico of twelve columns in front. (See note to HEXASTYLE.) There is no portico of this description in London at present. The lower one of the west front of St Paul's Cathedral (Plate LXIV.) is of twelve columns, but they are coupled, making the arrangement pseudo-dodecastyle. (See PSEUDO-PROSTYLE.) The Chamber of Deputies in Paris has a true dodecastyle.

DOME (Gr. δωμα, a structure of any kind; whence the Latin *domus*, a house or temple), a cupola or inverted cup on a building. The application of this term to its generally received purpose is from the Italian custom of calling an archiepiscopal church, by way of eminence, *Il duomo*, the temple; for to one of that rank, the cathedral of Florence, the cupola was first applied in modern practice. The Italians themselves never call a cupola a dome: it is on this side of the Alps the mistake has arisen, from the circumstance, it would appear, that the Italians use the term with reference to those structures whose most distinguishing feature is the cupola, tholus, or (as we now call it) dome. (See CUPOLA.)

† DRIPSTONE, the moulding or cornice which acts as a canopy to doors and windows. Horizontal running mouldings are sometimes called tablets and sometimes dripstones.

DROPS. (See GUTTÆ.)

ECHINUS (Gr. εχινος, an egg), a moulding of eccentric curve, which (when it is carved) being generally cut into the forms of eggs and anchors alternating, the moulding is called by the name of the more conspicuous. It is the same as Ovalo, *q. v.*

ELEVATION, the front, or *façade* as the French term it, of a structure. A geometrical drawing of the external upright parts of a building. Architects speak of front, back-front, and side or end elevations.

ENTABLATURE or INTABLATURE (Lat. *in*, upon, and *tabula*, a tablet). The superimposed horizontal mass in a columnar ordinance, which rests upon the tablet or abacus of a column, is so called. It is conventionally composed of three parts, architrave, frieze, and cornice, *q. v.* Plate LXII. fig. 1.

ENTASIS (Gr. εντασις, a stretching or swelling). Columns are said to have entasis when they do not diminish regularly, but in a curved line.

EPISTYLIUM or EPISTYLE (Gr. επι, upon, and στυλος, a column). This term may with propriety be applied to the whole entablature, with which it is synonymous; but it is restricted in use to the architrave or lowest member of the entablature.

ESCAPE, a familiar English equivalent for the term Apophyge, *q. v.*

EUSTYLE (Gr. ευ, well, and στυλος, a column), a species of intercolumniation, to which a proportion of two diameters and a quarter is assigned. This term, together with the others of similar import,—pycnostyle, systyle, diastyle, and aræostyle,—referring to the distances of columns from one another in composition, is from Vitruvius, who assigns to each the space it is to express. It will be seen, however, by reference to them individually, that the words themselves, though perhaps sufficiently applicable, convey no idea of an exactly defined space, and by reference to the columnar structures of the ancients, that no attention was paid by them to such limitations. It follows, then, that the proportions assigned to each are purely conventional, and may or may not be attended to without vitiating the power of applying the terms. Eustyle means the best or most beautiful arrangement; but as the effect of a columnar composition depends on many things besides the diameter of the columns, the same proportioned intercolumniation would look well or ill according to those other circumstances; so that the limitation of eustyle to two diameters and a quarter is absurd, and so it is in the case of the other similar terms. With Doric intercolumniation it is different, as may be seen by reference to the word MONOTRIGLYPH.

FAÇADE. (See ELEVATION.)

FASCIA (Lat. a band). The narrow vertical bands or broad fillets into which the architraves of Corinthian and Ionic entablatures are divided, are called fasciæ or fascias; and the term is generally applied to any similar member in architecture.

† FEATHERINGS. (See FOLIATIONS.)

FILLET, a narrow vertical band or listel, of frequent use in congeries of mouldings, to separate and combine them, and also to give breadth and firmness to the upper edge of a crowning cyma or cavetto, as in an external cornice. The narrow slips or breadths between the flutes of Corinthian and Ionic columns are also called fillets.

† FINIAL (Lat. *finis*, the end). The term is equivalent to the Greek Acroterium. It is applied to the carved apex of pediments, piers, pinnacles, and canopies.

FLUTE, a concave channel. Columns whose shafts are channelled are said to be fluted, and the flutes are collectively called flutings.

† FOLIATIONS or FEATHERINGS, small arches meeting in points or cusps, which are plain or enriched. They are used as an enrichment in tracery, and are distinguished as trefoils, quatrefoils, and cinquefoils, as the case may be.

FRIEZE (Ital. *fregio*, from the Lat. *Phrygionius*, enriched or embroidered), that portion of an entablature between the cornice above and the architrave below. Plate LXII.

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fig. 1. It derives its name from being the recipient of the sculptured enrichments either of foliage or figures which may be relevant to the object of the structure. The frieze is also called the zoöphorus, *q. v.*

Frontispiece, the front or principal elevation of a structure. This term, however, is generally restricted in application to a decorated entrance.

Gable. When a roof is not hipped or returned on itself at the ends, its ends are stopped by carrying up the walls under them in the triangular form of the roof itself. This is called the gable, or, indeed, the pediment. The latter term, however, is restricted to the ornamental and ornamented gable; and gable itself is applied to a plain triangular end.

Glyph. (See Triglyph.)

Gradino (Ital. dim. of *gradus*, a step). Architects frequently use the plural of this term, gradini, and to gradinate, instead of the English, steps, and to graduate, perhaps without sufficient reason, though they find them useful to distinguish what they intend from the meaning of the latter words in their ordinary acceptation.

Groining. In vaulting or arching over from insulated piers, the cross vaults meet in angles, and lead to a common centre or apex. This is called groining.

Guiloche or Guilochos (Gr. γυιον, a member, and λοχος, a snare). An interlaced ornament like network, used most frequently to enrich the torus. Plate LVII.

Guttæ (Lat. drops). The small cylindrical drops used to enrich the mutules and regulæ of the Doric entablature are so called.

Helix (Gr. ἑλιξ, a wreath or ringlet), used synonymously with Cauliculus, *q. v.* It forms in the plural Helices.

Hemiglyph (Gr. ἡμισυς, half, and γλυφη, an incision or channel). The half-channels, or rather chamfered edges, of a triglyph tablet, may be so called. The two hemiglyphs are included to make the third channel, and complete the triglyph. (See Triglyph.)

Hexastyle (Gr. ἑξ, six, and στυλος, a column). A portico of six columns in front[1] is of this description. Most of the churches in London which have porticoes have hexaprostyles. (See Prostyle.)

Hypæthral. (See Hypæthros.)

Hypæthros (Gr. ὑπο, under, and αιθρα, the air), a temple open to the air, or uncovered. The Greeks frequently made the temples of the supreme divinities hypæthral. For instance, those of Jupiter Olympius at Agrigentum in Sicily, of Neptune at Pæstum, and of Minerva Parthenon at Athens, are all of this description. The term may be the more easily understood by supposing the roof removed from over the nave of a church in which columns or piers go up from the floor to the ceiling, leaving the aisles still covered. In that case it would be hypæthral, after the manner of the Greek hypæthros. The Pantheon in Rome having an opening in the centre of the dome, is thereby rendered hypæthral. See Plates LIII. and LX. fig 4 and 5.

Hypogea (Gr. ὑπο, under, and γη, the earth). Constructions under the surface of the earth, or into the sides of a hill or mountain, are hypogea.

Hypotrachelium (Gr. ὑπο, under, and τραχηλος, the neck), the moulding or the groove at the junction of the shaft with the capital of a column. In some styles the hypotrachelium is a projecting fillet or moulding, and in others, as the Doric, it is composed of a channel or groove, and sometimes of more than one. Plate LXII. fig. 1.

Ichnography (Gr. ιχνος, a footstep or track, and γραφη, a description or representation). A plan, or the representation of the site of an object on a horizontal plane, is its ichnography. The term *plan* (*q. v.*) is, however, much more frequently used.

Impost (Lat. *impositus*, laid upon). The horizontal congeries of mouldings forming the capital of a pier, or edge pilaster, which has to support one leg of an arch, is called the impost; sometimes, and more conveniently, this term is used for the pilaster itself, when its capital is called the impost cap or impost mouldings.

Intercolumniation (Lat. *inter*, between, and column, *q. v.*) The distance from column to column, the clear space between columns, is called the intercolumniation.

Jamb, the side-post or lining of a doorway or other aperture. The jambs of a window outside the frame are called reveals.

† Label, the level moulding or dripstone over a door or window, common in the later Pointed works. It is generally turned down at the ends at right angles, and slightly returned again horizontally and outwards.

Lacunar (Lat.), a panelled or coffered ceiling or soffit. The panels or cassoons of a ceiling are more classically called *lacunaria.*

† Lancet. A term familiarly applied to the simplest form of the Pointed arch, which is that of the outer end of the surgical instrument, the lancet.

† Lantern (Lat. *lanterna*), a turret raised above a roof or tower, and very much pierced, the better to transmit light. In modern practice this term is generally applied to any raised part in a roof or ceiling, containing vertical windows, but covered in horizontally.

Metope (Gr. μετοπη, a middle space), the square recess between the triglyphs in a Doric frieze. It is sometimes occupied by sculptures. Plates LIII. and LIV. fig. 4.

Mezzanine (Ital. *mezzanino*, dim. of *mezzo*, the middle), a low story between two lofty ones. It is called by the French entresol, or inter-story.

Mitre. A moulding returned upon itself at right angles is said to mitre. In joinery, the ends of any two pieces of wood of corresponding form cut off at 45°. necessarily abut upon one another so as to form a right angle, and are said to mitre.

Modillion (Lat. *modulus*, a measure of proportion), so called because of its arrangement in regulated distances; the enriched block or horizontal bracket generally found under the cornice of the Corinthian entablature. Plate LXII. fig 1. Less ornamented, it is sometimes used in the Ionic. See also Mutule.

Module (Lat. *modulus*, from *modus*, a measure or rule). This is a term which has been generally used by architects in determining the relative proportions of the various parts of a columnar ordinance. The semidiameter of the column is the module, which being divided into thirty parts called minutes, any part of the composition is said to be of so many modules and minutes, or minutes alone, in height, breadth, or projection. The whole diameter is now generally preferred as a module, it being a better rule of proportion than its half.

Monopteral. (See Monopteros.)

Monopteros (Gr. μονος, one, or single, and πτερον, a wing). This term is incorrectly used by Vitruvius to describe a temple composed of a circular range of columns supporting a tholus, cupola, or dome, but without walls. (See Peripteral.) Such an edifice would be more correctly designated as Cyclostylar, *q. v.*

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[1] The words "in front" are used to prevent the mistake which might arise from a supposition that all the columns in a portico should be counted to designate it. The porticoes of the churches of St Martin-in-the-Fields, and St Mary-le-bone, in London, for instance, have each eight columns, but are hexastyle nevertheless, there being but six in their front rows respectively.

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MONOTRIGLYPH (Gr. μονος, one, or single, and *triglyph*, *q. v.*) The intercolumniations of the Doric order are determined by the number of triglyphs which intervene, instead of the number of diameters of the column, as in other cases; and this term designates the ordinary intercolumniation of one triglyph. Plate LIV. fig. 1.

MOULDINGS, eccentric curves of various kinds, intended to enrich and ornament, by producing light and shade, and obviating the monotony attendant on many flat and angular surfaces. They may be variously carved to increase their efficiency. The most usual forms of mouldings are called the cyma-recta and reversa, cavetto, scotia, torus, astragal or bead, and the echinus or ovalo, *q. v.* Plate LVII. In Pointed architecture, mouldings are not limited either to those names or to the forms they are intended to designate, nor indeed is any other style, except by absurd custom and authority.

† MULLION, the columnar vertical bar used to divide a window into breadths; the trunk out of which tracery flows.

MUTULE (Lat. *mutulus*, a stay or bracket), the rectangular impending blocks under the corona of the Doric cornice, from which guttæ or drops depend. Mutule is equivalent to modillion, but the latter term is applied more particularly to enriched blocks or brackets, such as those of Ionic and Corinthian entablatures.

NAOS (Gr. ναος, a temple). This term is sometimes used instead of the Latin cella, as applied to the interior; strictly, however, it means the body of the edifice itself, and not merely its interior or cell.

NEWEL, the solid or hollow column or cylinder which bears up the handrail of a staircase at the foot and in the most material parts. It means also the core or hollow, as the case may be, about which a circular staircase winds.

NICHE, a concave recess in a wall, with a straight or circular head. Niches are generally made to receive statues, vases, &c.

OCTASTYLE (Gr. οκτω, eight, and στυλος, a column). A portico of eight columns in front. (See note to HEXASTYLE.) There is no portico in London of this description at present, though the upper one of the west front of St Paul's (Plate LXIV.) is of eight columns; but they are coupled, making the arrangement tetrastyle. It may indeed be called a pseudo-octa-prostyle. (See PSEUDO-PROSTYLE.)

OGEE, the vulgar name for the Cyma, *q. v.*

OPISTHODOMUS (Gr. οπισθεν, behind, and δομος, a house or other edifice), the part behind a Greek temple corrresponding with the Pronaos before it. (See PRONAOS.)

ORDER. A column with its entablature and stylobate is so called. (Plate LXII. fig. 1.) The term is the result of the dogmatic laws deduced from the writings of Vitruvius, and has been exclusively applied to those arrangements which they were thought to warrant.

ORDINANCE, a composition of some particular order or style. It need, not, however, be restricted to a columnar composition, for it will apply to any species which is subjected to conventional rules for its arrangement.

ORTHOGRAPHY (Gr. ορθος, straight or true, and γραφη, a description or representation). A geometrical elevation of a building or other object, in which it is represented as it actually exists, or may exist, and not perspectively, or as it would appear, is called its orthography.

ORTHOSTYLE (Gr. ορθος, straight or true, and στυλος, a column), any straight range of columns. This is a term suggested to designate what is generally but improperly called a peristyle, *q. v.;* that is, columns in a straight row or range, but not forming a portico.

OVALO (Ital.), egg-formed (see ECHINUS). This is the name most commonly applied to the moulding which appears to have originated in the moulded head of the Doric column, and, with an abacus, forming its capital.

PANEL, a compartment with raised margins, moulded or otherwise. Deep panels in a ceiling are called Cassoons and Lacunaria, *q. v.*

PARAPET (Ital. *parapetto*, against the breast or breast-high), the low breast-high wall which is used to front terraces and balconies, to flank bridges, &c. The most common application of the term in this country is to so much of the external walls of a house as stands above the flats and gutters of the roof behind.

PARASCENIUM, in a Greek theatre, the wall at the back of the stage.

PARASTAS (Gr. παραστας, standing before), antæ or end pilaster. This is the Greek term for which the Latin antæ is generally used. It has the same meaning, and they may be used alternatively. (See ANTÆ.)

PEDESTAL (Gr. πους, a foot, and στυλος, a column). An insulated stylobate is for the most part so called. The term is, moreover, generally applied to any parallelogramic or cylindrical mass, used as the stand or support of any single object, as a statue or vase.

PEDIMENT, that part of a portico which rises above its entablature to inclose the end of the roof, whose triangular form it takes. The cornice of the entablature, or its corona and part of the bed-mould only, with the addition of a cymatium, bounds its inclined sides, and gives it an obtuse angle at the apex. In pointed architecture, however, the angle of a pediment is for the most part acute.

† PENDENT (Lat. *pendens*, hanging). In some of the later works of the Pointed style, large masses depend from enriched ceilings, and appear to be formed by the other legs of intersecting arches: these are called pendents. They also occur in canopies. See Plate LXXI. fig. 1, 8, 9, 11, and 12.

PERIBOLUS (Gr. περι, around or about, and βαλλω, to throw), an inclosure. Any inclosed space is a peribolus; but the term is applied more particularly to the sacred inclosure about a temple. The wall forming the inclosure is also called the peribolus.

PERIPTERAL. (See PERIPTEROS.)

PERIPTEROS (Gr. περι, around or about, and πτερον, a wing). A temple or other structure with the columns of its end prostyles, or porticoes, returned on its sides as wings, at one intercolumniation distant from the walls. Almost all the Doric temples of the Greeks were peripteral. The term is, however, incorrectly applied by Vitruvius to peristylar structures, though it is clear that a perfectly round building, such as he describes to be peripteral, cannot be said to be winged or to have wings.

PERISTYLAR, having a peristyle. (See PERISTYLE.)

PERISTYLE (Gr. περι, around or about, and στυλος, a column), a range of columns encircling an edifice, such as that which surrounds the cylindrical drum under the cupola of St Paul's. The columns of a Greek peripteral temple form a peristyle also, the former being a circular, and the latter a quadrilateral peristyle. The same term is generally but incorrectly applied to a range of columns in almost any situation when they do not form a portico. (See ORTHOSTYLE.

PIER. The solid parts of a wall between windows, and between voids generally, are called piers. The term is also applied to masses of brickwork or masonry which are insulated to form supports to gates or to carry arches.

PILASTER (Lat. *pila*, a pillar, and the Ital. augmentative *astro*, which indicates an inferior quality), an inferior sort of column or pillar; a projection from or against a pier, having the form and decorations of antæ, when used correctly; but too frequently they have capitals, like those of columns, assigned them.

PILLAR (Lat. *pila*, and Ital. *piliere*), a columnar mass of no particular form. Columns are vulgarly called pillars; but

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architects make a distinction, restricting this term to such pillars as do not come within the description of a column. (See Column.)

Pillowed. A swollen or rounded frieze is said to be pillowed or pulvinated.

† Pinnacle, the slender tapering head of a turret or buttress. A small spire, or the head of a spire or steeple.

Plan, a horizontal geometrical section of the walls of a building; or indications, on a horizontal plane, of the relative positions of the walls and partitions, with the various openings, such as windows and doors,—recesses and projections, as chimneys and chimney-breasts,—columns, pilasters, &c. This term is often incorrectly used in the sense of Design, *q. v.*

Planceer is sometimes used in the same sense as soffit, but incorrectly, as it is from the French *plancher*, to board or floor. It is more particularly applied to the soffit of the corona in a cornice.

Plinth (Gr. πλινθος, a square tile). In the Roman orders the lowest member of the base of a column is square and vertically faced; this is called a plinth.

Podium, strictly something upon or against which the foot may be placed; and in this sense probably it was applied to the wall which bounds the arena of an amphitheatre, and is thereby at the feet of the most advanced of the spectators.

Polytriglyph (Gr. πολυς, many, and triglyph, *q. v.*) An intercolumniation in the Doric order of more than two triglyphs. (See Monotriglyph and Ditriglyph.)

Portico (an Italicism of the Lat. *Porticus*), an open space before the door or other entrance to any building, fronted with columns. A portico is distinguished as prostyle, or *in antis*, as it may project from or recede within the building, and is designated with either of these terms by the number of columns its front may consist of. (See Distyle, Tetrastyle, Hexastyle, Octastyle, &c.)

Porticus (Lat. See Portico). In an amphiprostylar or peripteral temple, this term is used to distinguish the portico at the entrance from that behind, which is called the posticum.

Posticum (Lat). A portico behind a temple. (See Porticus and Portico.)

Pronaos (Gr. προ, before, and ναος, a temple). The inner portico of a temple, or the space between the porticus, or outer portico, and the door opening into the cella. This is a conventional use of the term; for, strictly, the pronaos is the portico itself.

Propylæum (Gr. προ, before, and πυλη, a portal), any structure or structures forming the entrance to the peribolus of a temple; also the space lying between the entrance and the temple. In common usage this term, in the plural (propylæa), is almost restricted to the entrance to the Acropolis of Athens, which is known by it as a name.

Propylon, an alternation in the Greek form of Propylæum (*q. v.*) in the Latin of Vitruvius.

Proscenium, in a Greek theatre, the stage.

Prostyle (Gr. προ, before, and στυλος, a column). A portico in which the columns project from the building to which it is attached is called a prostyle. It is tautologous to say a prostyle portico,—a prostyle is a portico. Custom, however, seems to warrant the impropriety, for the word portico is always superadded. In determining the number of columns of which a portico consists, the Greek numerals are prefixed to the term Style, *q. v.*, and prostyle is repeated. It would be more concise, and, at the least, equally correct, to put the numeral before prostyle, and say tetra-prostyle, hexa-prostyle, &c., instead of tetrastyle-prostyle, &c.; as the custom is; that mode is adopted in this article throughout.

Pseudo-dipteral (Gr. ψευδης, false, and dipteral, *q. v.*), false, double-winged. When the inner row of columns of a dipteral arrangement is omitted, and the space from the wall of the building to the columns is preserved of the consequent double projection, it is pseudo-dipteral. The portico of University College London is pseudo-dipterally arranged, the returning columns on the ends or sides not being carried through behind those in front.

Pseudo-peripteral (Gr. ψευδης, false, and peripteral, *q. v.*), false-winged. A temple having the columns on its flanks attached to the walls, instead of being arranged as in a peripteros, is said to be pseudo-peripteral.

Pseudo-prostyle (Gr. ψευδης, false, and prostyle, *q. v.*) This is a term not in general use, but is here suggested to designate a portico projecting less than the space from one column to another, as the western porticoes to St Paul's Cathedral, and the portico to the East India House, in London; but that they are recessed also, and therefore may be described as pseudo-prostyle and recessed. The front of Trinity Church in the New Road, near the Regent's Park, London, presents a mere pseudo-prostyle.

Pulvinated (Lat. *pulvinus*, a cushion or bolster), a term used to express the swelling or bolstering of the frieze, which is found in some of the inferior works of the Roman school, and is common in Italian practice. It is used indifferently with pillowed.

Pycnostyle (Gr. πυκνος, dense, and στυλος, a column), columns thickly set. The space or intercolumniation implied by this term is one diameter and a half. (See Eustyle.)

† Quatre-Foil, tracery in four foliations or featherings, but applicable only to circular or square panels, and not to arches.

Quoin (Lat. *ancon*, an elbow or corner, whence the Fr. *coin*), an outer corner. The stones which are made to project from the regular surface of the walls at the outer angles of a building are technically called quoins. The front of the Farnese Palace exemplifies them. (See Plate LXVI.)

Regula (Lat.), a rule or square. The short fillet or rectangular block, under the tænia, on the architrave of the Doric entablature, is so called.

† Rose or Catherine-wheel Window, the large circular window filled with various tracery, which is common in the upper part of transept fronts in churches and cathedrals. Plate LXVIII. fig. 1.

Scotia (Gr. σκοτια, shadow or darkness), a concave moulding most commonly used in bases, which projects a deep shadow on itself, and is thereby a most effective moulding under the eye as in a base. It is like a reversed ovalo, or rather what the mould of an ovalo would present. Plate LVII.

Scroll, synonymous with volute. The term scroll is commonly applied to the more ordinary purposes, whilst volute is generally restricted to the scrolls of the Ionic capital.

Section, a drawing shewing the internal heights of the various parts of a building. It supposes it to be cut through entirely, so as to exhibit the walls, the heights of the internal doors, and other apertures; the heights of the stories, thicknesses of the floors, &c. It is one of the species of drawings necessary to the exhibition of a Design, *q. v.*

Shaft. The body or tapering cylindrical mass of a column, from the base below to the capital above, is so called. Plate LXII. fig. 1.

Sill or Sole (Lat. *solum*, a threshold, whence the Fr. *seuil*). The horizontal base of a door or window-frame is called its sill, though in practice a technical distinction is made between the inner or wooden base of the window-frame, and the stone base on which it rests,—the latter being called the sill of the window, and the former that of its

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frame. This term is not restricted to the bases of apertures; the lower horizontal part of a framed partition is called its sill. It is sometimes incorrectly written cill.

SOFFIT (Ital. *soffitta*, a ceiling), the inverted horizontal face of anything. The horizontal face of an entablature resting on, and lying open between, the columns, is its soffit. The underface of an arch, where its thickness is seen, is its soffit.

SPANDREL. The unoccupied angles, or rather the excluded triangles, of a square described about a circle, are called spandrels; whence almost any triangular space is designated by the same term.

† SPIRE, the tapering mass which forms the summit of a steeple.

STEEPLE. This term is used in contradistinction to tower, the latter being upright, or nearly so, and terminating almost abruptly, or with pinnacles, and the steeple running to a point with sides converging from the base upwards, or from a certain height only.

STELE (Gr. στηλη, a cippus or small monument). The ornaments on the ridge of a Greek temple, answering to the antefixæ on the summit of the flank entablatures, are designated stelai.

STEREOBATE (Gr. στερεος, firm or solid, and βασις, a base or fulciment), a basement. It is here sought to make a distinction between this term and Stylobate, *q. v.*, by restricting the latter to its real import, and applying stereobate to a basement in the absence of columns.

STOA (Gr. στοα, a portico). This is the Greek equivalent for the Latin porticus and the Italo-English portico, *q. v.*

STRING or STRING-COURSE, a narrow, vertically-faced, and slightly projecting course in an elevation. If window-sills are made continuous, they form a string-course; but if this course is made thicker or deeper than ordinary window-sills, or covers a set-off in the wall, it becomes a blocking-course.

STYLE (Gr. στυλος, a column). The term style, in architecture, has obtained a conventional meaning beyond its simpler one, which applies only to columns and columnar arrangements. Eustyle, *q. v.*, is a graceful distribution of columns as to space, and so it may be taken to apply to any good and pleasing distribution of solids and voids in the composition of a structure. But Eustyle being a condition of style not always found, or not recognized, in all architectural compositions, the term is taken without the qualifying prefix, and is applied with such qualifications and descriptions as may be necessary to make it available to all classes of architectural composition. Style as a term in architecture must be understood to be in no sense the same word as style in literature.

STYLOBATE (Gr. στυλος, a column, and βασις, a base or fulciment), a basement to columns. (See STEREOBATE.) Stylobate is synonymous with pedestal, but is applied to a continued and unbroken substructure or basement to columns, while the latter term is confined to insulated supports.

SURBASE (Lat. *super*, whence the Fr. *sur*, above or upon, and *base*, *q. v.*), an upper base. This term is applied to what, in the fittings of a room, is familiarly called the chair-rail. It is also used to distinguish the cornice of a pedestal or stereobate, and is separated from the base by the dado or die.

SYSTYLE (Gr. συν, together with, and στυλος, a column), columns rather thickly set. An intercolumniation to which two diameters are assigned. (See EUSTYLE.)

TABERNACLE, a canopied recess or niche. The rich ornamental tracery forming the canopy, &c., to a tabernacle, is called tabernacle-work: it is common in the stalls and screens of cathedrals, and in them is generally open or pierced through.

† TABLET. Projecting mouldings, or moulded strings in the Pointed style, are better described as tablets than as cornices.

TÆNIA (Lat.) a band. (See BAND.)

TERMINAL. Figures of which the upper parts only, or perhaps the head and shoulders alone, are carved, the rest running into a parallelopiped, and sometimes into a diminishing pedestal, with feet indicated below, or even without them, are called terminal figures.

TETRAPROSTYLE. (See TETRASTYLE and PROSTYLE.)

TETRASTOÖN (Gr. τετρα, four, and στοα, a portico). An atrium or rectangular court-yard, having a colonnade or projected orthostyle on every side, is called a tetrastoön.

TETRASTYLE (Gr. τετρα, four, and στυλος, a column), a portico of four columns in front. (See note to HEXASTYLE.)

THOLOBATE (Gr. θολος, a dome or cupola, and βασις, a base or substructure), that on which a dome or cupola rests. This is a term not in general use, but it is not the less of useful application. What is generally termed the attic above the peristyle and under the cupola of St Paul's, would be correctly designated the tholobate. A tholobate of a different description, and one to which no other name can well be applied, is the circular substructure to the cupola of the Univ. Coll. London.

THOLUS or THOLOS (Gr.), a dome or cupola, or any round edifice. This is the only term used by Greek writers that can be supposed to apply to the conoidal chambers which approach, in internal form, to that of the modern cupola or dome, and is therefore made the Greek equivalent for those terms.

TORUS (Lat.), a protuberance or swelling, a moulding whose form is convex, and generally nearly approaches a semicircle. It is most frequently used in bases, and is for the most part the lowest moulding in a base. Plate LVII.

TOWER, a circular, square, or polygonal structure, with upright or slightly converging sides, running to a height equal to or greater than its diameter or base, and terminating abruptly or in horizontal lines. A tower may be flanked by buttresses whose pinnacles surmount it, and be superimposed by a turret, lantern, or spire.

† TRACERY. The transoms, mullions, and interlaced or flowing continuations of the latter, with their foliations in windows, on doors, panels, and in tabernacle-work, are so called. The ribs on groined ceilings, and almost all eccentric moulded enrichments, come under the same denomination.

TRACHELIUM (Gr. τραχηλος, the neck). In Doric and Ionic columns there is generally a short space intervening between the hypotrachelium and the mass of the capital, which may be called the trachelium or neck.

TRANSEPT. In a church of which the plan is in the form of a cross, the arms lying across at the intersection of the nave and chancel form the transept. Commonly each arm is spoken of as a transept, but strictly the transept is one.

† TRANSOM, the horizontal bar used to divide a mullioned window into heights; the straight and horizontal parts of tracery.

† TREFOIL, tracery in three foliations or featherings.

TRIGLYPH (G. τρεις, three, and γλυφη, an incision or channel). The vertically channelled tablets of the Doric frieze are called triglyphs, because of the three angular channels in them, two perfect and one divided; the two chamfered angles or hemiglyphs being reckoned as one. The square sunk spaces between the triglyphs on a frieze are called metopes.

TRUSS, a term in carpentry; but, probably by some abuse, it has been made to apply to consols, or ornamented corbels. (See CONSOL.)

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† TURRET, a small tower, or a tower of small base in proportion to its height. Turrets are sometimes placed on the angles of towers; but in the later works of the style they are attached to the angles of structures instead of buttresses, and they run up above their height in lieu of pinnacles.

TYMPANUM (Gr. τυμπανον). The triangular recessed space inclosed by the cornice which bounds a pediment. The Greeks sometimes placed sculptures representing subjects in connection with the purposes of the edifice, in the tympana of temples.

VAULT (Ital. *Voltato*, turned over). An arched ceiling or roof. A vault is, indeed, a laterally conjoined series of arches. The arch of a bridge is, strictly speaking, a vault. Intersecting vaults are said to be groined. (See GROINING.)

VOLUTE (Lat. *volutum*, from *volvo*, rolling up or over, convolving). The convolved or spiral ornament which forms the characteristic of the Ionic capital is so called. The common English term is scroll, *q. v.* Volute, scroll, helix, and cauliculus, are used indifferently for the angular horns of the Corinthian capital.

ZOÖPHORUS (Gr. ζωον, an animal, and φερω, to bear). This term is used in the same sense as frieze, and is so called because that part of the entablature is made the receptacle of sculptures which are frequently composed of various animals.

DESCRIPTIONS AND EXPLANATIONS OF THE PLATES.

Plate L. The view of the Parthenon in its present state is from an original drawing made on the spot in the year 1821, by Mr W. W. Jenkins. It consequently exhibits the appearance of the splendid ruin before the disasters of the last revolution befell it, as the restored view, under the same aspect, does of the structure in its original state. This is introduced as a frontispiece to the subject, as being an acknowledged master-work of architecture, as well as to enable the reader the better to understand the details of the style of which it is an example, and the composition of that class of structures of which it may be reckoned the principal.

Plate LI. This plate exhibits the varieties of columns and columnar composition which the ancient architecture of various countries presents, and is intended to elucidate their presumed derivation from the single pillar of the earliest records; together with specimens of ancient modes of structure.

Fig. 1 presents an example of the single pillar or stone of memorial, the Monolithon; fig. 2 of the Bilithon, the cromlech of the Celtic nations; fig. 3 of the Trilithon, an example afforded by Stonehenge; and fig. 4 exhibits the immediately succeeding arrangement of pillars, with a continuous entablature.

Fig. 5 shows the flank of the portico of the temple at Amada in Nubia, consisting of square piers or pillars as in fig. 4, and a cylindrical column, which is evidently formed of a similar pillar by working off its angles, the abacus and plinth remaining of the same size and form of which the pillars are.

Fig. 6, pillars with a plain entablature as in fig. 4, from the Rhamesseion at Thebes. The statues placed before the pillars most probably gave rise to the use of such figures to support an entablature, which these have the appearance of doing when seen in front.

Fig. 7, an early Egyptian columnar composition, from Thebes also. In this, as in the example at Amada, the square abacus shows the form and size of the original pillar out of which the singular bulbous column has been sculptured.

Fig. 8, piers of one of the cavern temples of Ellora. These likewise exhibit the tendency to the cylindrical form, and may be assumed as an example of the style of architectural columnar composition at the time they were executed.

Fig. 9, ancient Hindoo columnar piers, in the Mokundra Pass, from Colonel Tod's second volume of the *Annals of Rajast'han*. The similarity in character which exists between these and the piers at Ellora in the preceding example, tends to strengthen the remark accompanying them, and affords proof of their contemporaneousness.

Fig. 10, Doric columns and their architrave from the ruins at Corinth, being the earliest known example of their style.

Fig. 11, ancient Persian columns from Persepolis, in front and in profile, the latter showing the mode in which they were probably made to receive an entablature, though it is stated that the capitals are wrought on the backs in such a manner as to render it improbable that they were ever intended to have anything placed on them.

Fig. 12, columns in front of the rock sculptures at Mundore, in Marwar, from Colonel Tod's first volume.

Fig. 13, from the ruins of Bheems Chlori, also in the Mokundra Pass, from Colonel Tod's second volume. These present another variety of Hindoo columnar composition of early date, though later, it is probable, than the example, fig. 9, *supra*. Figs. 14 and 16 exhibit the modes of structure described in the text at page 440; and fig. 15 is a view of the entrance to the great pyramid at Memphis, from Denon, and shows the mode of its structure.

Plate LII. An example of the Egyptian style, sufficiently explained at pp. 436, 458, *et seq.*

Plate LIII. A Greek Doric octastyle, peripteral, and hypæthral temple, with the details of the Parthenon. The plan (fig. 3) is that of the Parthenon (*vide* Plate L.) slightly modified, the better to include the class to which it belongs. In the Parthenon, the opisthodomus has six columns, as in the pronaos, and not four *in antis*, as here laid down: this, however, exhibits the ordinary mode of arrangement. The internal columns are arranged in this plan as they are generally found in other similar structures; and the pedestal for the statue of the divinity is placed in its most probable position.

Fig. 1. shows part of the flank of the temple and the internal composition of the hypæthral cella with its upper range of columns or attic, of the inner chamber or treasury, and of the opisthodomos and posticum: much of this, however, is necessarily taken at a venture, because of the imperfect state of the remains of the Grecian edifices.

Fig. 2 exhibits an elevation of the opisthodomus behind the outer range of the portico, not according to the Parthenon, but *in antis.*

Fig. 3 is the plan. In front, on the left-hand side, is the entrance porticus; behind this is the pronaos; within the pronaos is the hypæthral naos or cella, the middle space between the columns being open; the spaces between the columns and the walls on either side are covered; doors (these are not generally laid down to the Parthenon, but are assumed as probable) lead to the inner chamber, said to be the treasury,—this is by some called the opisthodomus, into which it opens, and the opisthodomus stands in the same relation to the posticum that the pronaos does to the porticus.

Fig. 4 is the external order of the Parthenon; fig. 5, the profile of its corona to a larger scale, to show its de-

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tail; fig. 6, a half-capital of the same, enlarged also, with its annulets larger still.

Fig. 9 is the order of the pronaos; fig. 8, the profile of its corona enlarged; fig. 7, its capital enlarged, with the annulets still larger.

Fig. 10, the antæ cap enlarged; and fig. 12 a half-plan of a column of the Parthenon, showing the contour of its flutes. (*Vide* page 463, *et seq.*)

Plate LIV. A Greek Doric hexastyle, peripteral, and cleithral temple, with the details of the temple of Theseus at Athens.

Fig. 1, front elevation of the temple.

Fig. 2, section behind the outer range of the portico, showing the elevation of the pronaos.

Fig. 3, plan of the temple. The arrangement of the porticus here (to the left) is pseudo-dipteral; a space equal to two intercolumniations and the intervening column being left between the external range and the front of the pronaos,—the projection of the posticum is irregular.

Fig. 4, the external order of the temple of Theseus, with a half-plan of the column; fig. 5, the profile of the corona enlarged; fig. 6, half the capital enlarged; fig. 7, half the capital of the order of the pronaos enlarged also; fig. 9, the antæ, with profiles of the outer and inner entablatures of the pronaos,—this shows also the arrangement of the ceilings.

Fig. 10, enlarged profile of the antæ cap.

Fig. 11, inverted plan of part of the ceilings of the porticus and pronaos, showing the arrangement of the coffers, lacunæ, or cassoons.

Fig. 12, inverted plan of the planceer of the cornice, showing the form and arrangement of the mutules of the external entablature.

Fig. 13, is a plan of the triglyphs of the same on an external angle.

Figs. 8 and 14 are enlarged plans of the flutings of the columns, to show their contours. (*Vide* p. 463, *et seq.*

Plate LV. A Greek Ionic hexa-prostyle apteral temple, with details of the temple of Erechtheus at Athens.

Fig. 1, elevation of the portico.

Fig. 2, rear elevation of the temple, showing an attached tetrastyle *in antis*, with windows as they exist in that of the temple of Erechtheus.

Fig. 3, flank elevation. The dotted projection to the right of the posticum indicates the amphiprostylar arrangement, which is shown on the plan fig. 4 also, and in the same manner.

Fig. 5, the order of the temple of Erechtheus, except the two lowest steps of the stylobate, which may be easily supplied, to a larger scale, with indications of the carved mouldings, &c.

Figs. 6, 7, and 8 are enlarged profiles of those parts of the entablature which are immediately behind and above them.

Fig. 10, the antæ of the same example, showing the ornament which enriches its necking, and runs along the flank of the edifice; fig. 11, profile of the antæ cap enlarged.

Fig. 12, flank elevation of the capital; all the vertical beads in this are carved. Fig. 13, transverse section of the capital.

Fig. 14, half the longitudinal section of the capital.

Fig. 15, an inverted plan of the capital, showing the arrangement of the flutings.

Fig. 16, an inverted plan of one of the angular capitals. (*Vide* p. 465, *et seq.*)

Fig. 9, The Ionic volute, enlarged to show the mode of striking it, and the contour of its face.

Plate LVI. Fig. 1 the elevation, fig. 2 the plan, and fig. 3 the details, of the order of the Choragic Monument of Lysicrates at Athens. (*Vide* p. 466.)

Fig. 4 presents the elevation, and fig. 5 the plan, of the Caryatic prostyle, which is attached to the flanks of the temple of Erechtheus at Athens.

Fig. 6 shows the details of the hands and feet of the figure, and of the entablature and stereobate of the same. *Vide* (p. 467.)

Plate LVII. contains Greek and Roman mouldings, with their usual enrichments, all drawn from ancient examples, and detached profiles of them all, together with two examples of Greek and one of Roman ornament. The specimen of Greek ornament on the left hand of the centre is from the neck of the antæ cap of the tetrastyle portico on the flank of the temple of Erechtheus, generally known as that of Minerva Polias; and the other half of the same is the enrichment of the neck of the antæ of the temple of Erechtheus itself, as shown in Plate LIX. figs 3 and 10. The Roman specimen of ornament is that of the frieze of the temple of Antoninus and Faustina in Rome. (*Vide* Plate LVIII. Ex. 3 and p. 467 and 477.)

Plate LVIII. Four Roman examples of the Corinthian order. Ex. 1 is that of the temple of Jupiter Stator in Rome; Ex. 2 is that of the temple of Vesta at Tivoli (*vide* Plate LX. fig. 9); Ex. 3 is that of the temple of Antoninus and Faustina (*vide* Plate LX. figs. 6, 7, and 8); and Ex. 4 is the example of the portico of the Pantheon in Rome (*vide* Plate LX. figs. 2, 3, 4, and 5). To every example fig. 1 shows the details enlarged, the shafts being cut away; and fig. 2 the elevation of the column and entablature. In every case, also, the distance from the inner surface of the column fig. 2 to the vertical line dividing the examples is one half the intercolumniation at which that example is composed. (*Vide* p. 473, *et seq.*)

Plate LIX. Examples of the Roman orders. Ex. 1 is the Corinthian of the Temple of Mars Ultor; Ex. 2 the Composite of the Arch of Titus (*vide* Plate LX. fig. 11); Ex. 3 the Ionic of the Temple of Fortuna Virilis (*vide* Plate LX. fig. 12); and Ex. 4 the Doric of the Theatre of Marcellus, completed from that of the Colosseum. All of these are in Rome. Figs. 1, as in Plate LVIII., show the entablatures, capitals, and bases, &c., on an enlarged scale; and figs. 2 the complete elevation of each order, except their stylobates, some of which are not ascertained, and those which are may be obtained from the structures they are referred to in Plate LX. (*Vide* p. 473, *et seq.*)

Plate LXIV. Elevations, plans, and sections of sundry Roman edifices, all drawn to the same scale.

Fig. 1 is a longitudinal elevation of the Colosseum. (*Vide* p. 469.)

Fig. 2 is the front elevation, fig. 3 the flank elevation, fig. 4 a section, and fig. 5 the plan, of the Pantheon. The dotted lines before the recess opposite the entrance, fig. 5, show the places the outstanding columns originally occupied. (*Vide* pp. 469 and 470.)

Fig. 6 is the front elevation, fig. 7 the plan, and fig. 8 the flank elevation, of the temple of Antoninus and Faustina: of this the front steps and stylobate are restorations. (*Vide* p. 469, and Pl. LVIII. Ex. 3.)

Fig. 9 is the plan and elevation of the temple of Vesta at Tivoli; of this the antefixæ and roof are restorations. (*Vide* Pl. LVIII. Ex. 2.)

Fig. 10 is the plan and elevation of the triumphal arch of Septimius Severus. (*Vide* p. 469.)

Fig. 11 is a plan and elevation of the arch of Titus. (*Vide ut sup.* and Pl. LIX. Ex. 2.)

Fig. 12 is a plan and elevation of the temple of Fortuna Virilis. (*Vide* p. 469, and Pl. LXIII. Ex. 3.)

Plate LXI. Plans, sections, elevations, &c., of Roman mansions from Pompeii.

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Fig. 1 is a plan of one of the most extensive and most regular of the domestic structures of Pompeii, with its immediate vicinage; it is known as the house of Pansa. The following nomenclature is generally that of Sir William Gell:—1, The entrance or recessed porch; 2, the vestibule; 3, the cavædium or atrium; 4, the compluvium or well for receiving the rain from the roof covering this part of the house (*vide* fig. 2); 5, penaria, or perhaps cubicula; 6, alæ or wings; 7, tablinum or palour; 8, pinacotheca, or perhaps the library; 9, a passage from the first to the second atrium without passing through the tablinum; 10, cubiculum or bed-chamber; 11, peristylium or oicus—the house; 12, impluvium (*vide sup. in* 4, *et* fig. 2); 13, exhedræ or alæ—in these the siesta was taken—they were also used for conversation; 14, cellæ familiaricæ; 15, triclinium—here couches and seats were placed, and company received; 16, lararium or receptacle for the family gods; 17, cubiculum; 18, hall to the gynæceum or women's apartment; 19, the gynæceum—this is believed by some to be a distinct house, and not a part of that of Pansa; 20, porticus or pergula; 21, hortus or garden; 22, a passage from the oicus to the pergula and garden, to avoid the necessity of passing through the triclinium; 23, kitchen; 24, storeroom or larder; 25, an open court, communicating with the street by a doorway. This comprehends the whole of the apartments, &c., appropriated to domestic use—the residence; the other portions of the edifice are distinct from it. 26 is another smaller house; 27, a passage leading to the house of Pansa from the street on the right-hand side; all the places marked 28 are shops open to the street, as shown in the elevation, fig. 3; the rooms marked 29 are storerooms to the shops into which they open; 30 is a bakehouse, in which the mills, &c., are indicated as they exist; 31 is the oven; in the angle of the two adjoining streets on the left hand (32) is the shop of a seller of wine and hot drinks; 33 is a fountain. The walls indicated on the other sides of the streets surrounding the house, &c., of Pansa are the fronts of shops and of some private houses, &c.

Fig. 2 is a section through the house of Pansa from the street to the garden, showing the manner in which it is probable the roofs, &c., were arranged.

Fig. 3 is the probable elevation of the entrance front of this mansion, though the sketch (fig. 4) of part of the same in its present state shows how slight the evidence for it is.

Fig. 5 is an outline of the side of a room, with the ornaments, &c., with which it is decorated. This is an average specimen: many were much plainer, and some were more enriched.

Fig. 6 is the plan of an ordinary sized house in one of the private streets of Pompeii: the uses of the various parts may be generally gathered from those of the similar portions of the house of Pansa. The word Salve, printed across the threshold, is there wrought in mosaic.

Fig. 7 presents the presumed arrangement of the roofs, &c., of this house in section.

Fig. 8 is the elevation of it towards the street. This cannot really have been better than it appears here, and such must have been the ordinary average appearance of the street fronts of Pompeian houses. (*Vide* p. 471, *et seq.*)

Plate LXII. Fig. 1, an example to show how the term order is applied, and what parts of it the various technical terms are applied to, or are intended to indicate.

Figs. 2, 3, 4, 5, and 6, are the orders of the Italo-Vitruvian school as arranged by Palladio; fig. 2, the Tuscan; fig. 3, the Doric; fig. 4, the Ionic; fig. 5, the Corinthian; and fig. 6, the Composite. (*Vide* p. 477.)

Plate LXIII. Varieties of Italian composition from existing structures in Italy and elsewhere, in the Italian style.

Figs. 1, 2, 3, 4, and 5, are windows of various form and arrangement.

Figs. 6, 7, 8, and 9, are doors of various composition, with plans to show their arrangement and ichnographic projections, &c.

Figs. 10, 11, 12, and 13, are arches and arcades, rusticated and with columns, &c. The plans show their forms and ichnographic projections. (*Vide* p. 478, *et seq.*)

Plate LXIV. Front elevations alone of the fronts of St Paul's in London and St Peter's in Rome. These two structures exhibit many of the peculiarities of the ecclesiastical architecture of the Italian school. In this plate their comparative magnitude has not been attended to; they are drawn to different scales to bring them more nearly of the same size, so as to render the contrast more effective. (*Vide* p. 452 and 455.)

Plate LXV. Flank elevations of St Peter's and St Paul's, drawn to the same scale, to show their comparative magnitude, and to enable the reader to judge of their respective merits, as well as to elucidate observations which will be found in the text *passim*. (*Vide* p. 455, &c.)

Plate LXVI. Elevations of three esteemed Italian mansions. The merit of this (the principal) elevation of the Farnese Palace is divided between Antonio Sangallo and M. A. Buonarotti. The Villa Giula, near Rome, is esteemed one of the best works of Giacomo Barozzi da Vignolia; and the villa Capra near Vicenza, by Palladio, is, by the admirers of his style, considered the most perfect of his works. (*Vide* pp. 452, 455, 478, 479, &c.)

Plate LXVII. A series of arches in the Gothic and Pointed styles, from various structures in England. It exhibits the advance of the circular arch from the plainness exhibited in figs. 1 and 2, to the richer and more complicate arrangements of those examples which follow, until the ingrafting and gradual advance of the pointed arch. This first appears in fig. 10. Fig. 12 shows the substitution of the latter for the circular of fig. 9 in a similar composition. Fig. 13 exhibits the pointed arch on Gothic pillars or columns; and fig. 14 the perfected pointed arch with the clustered shafts which become identified with the Pointed style. (*Vide* p. 479, *et seq.*)

Plate LXVIII. The elevation of the south transept of Beverley Minster. This affords a perfect and beautiful example of external composition of the first period of Pointed architecture. The presence of the circular arch embracing the pointed arches of the doorway, and composing with others, shows how gradual the advance of the new style was; the upper part of the front showing also how completely it was already systematized when the circular arch was not yet quite discarded. The plan of this front shows the various ichnographic projections, and the arrangement of the clustered shafts of the doors and windows. Fig. 2 is a niche in front of, and fig. 3 a pinnacle to, one of the buttresses of the nave of the same edifice: these are of the second period. Figs. 4, 5, 6, 7, and 8, are windows from various edifices, showing the gradual advance from the plain lancet arch of the Beverley Minster transept to the arch the most elaborately enriched with tracery. Fig. 4 is but a modification of the composition of the doorways of fig. 1, as that is of figs. 9 and 12, Plate LXVII.; and the advance from that may be almost termed natural.

Plate LXIX. Fig. 1 is a sectional compartment of the nave of Lincoln Cathedral; it exhibits the mode of internal composition peculiar to the style of the first period; tending, however, to the transition, it will be observed, in many particulars, and as a comparison of it with the adjacent example, of the next period, will more clearly show.

Fig. 2 is a similar sectional compartment of the choir of Lincoln Cathedral; exemplifying the internal compo-

sition of the second period of the Pointed style; the plans of the shafts to both examples show their forms and arrangement. The subjects of the last three plates are drawn entirely, by his kind permission, from Mr Britton's *Chronological History of Ecclesiastical Architecture.*

Plate LXX., the front of York Minster, exemplifies the external composition of the second period, as that of Beverley Minster transept (Plate LXVIII. fig. 1) does that of the first period; and the difference will be rendered very clear by comparing them. The upper parts of the towers of the front of York Minster, however, it must be remembered (*vide* p. 482) are of the third period, and so is the central tower which appears in the distance between them.

The front of Pisa Cathedral is here introduced in contrast with that of York Minster, to show the striking difference which exists between the real Gothic achitecture of Italy and the Pointed style which superseded it so completely, in this country particularly, and to elucidate our observations to that effect at page 445 *et seq.* The cupola which appears behind and in the distance is surrounded at the base by pointed arches and pinnacles, all of which are evidently of much later date than the Gothic front.

Plate LXXI. Fig. 1 is an elevation of Westminster Hall. It exemplifies the style of external composition of the third period. It was selected because of the variety of matter it contains elucidatory of the period to which it belongs particularly, and of the Pointed style generally. The door, windows, and canopied tabernacles on the second story of the towers, are peculiar; the lower tabernacles, are more general, and the pinnacles, crockets, corbels, tablets, &c., may also be taken in exemplification of such things in the style generally.

Fig. 2 is a plan of the front, showing the ribs of the groined entrance, the ichnographic projections of the tabernacles, &c.

Fig. 3 is one of the flying buttresses of the flank of the edifice.

Fig. 4 is a spandrel of the entrance porch enlarged.

Fig. 5, crockets of the gable running from the towers to the crowning turret, enlarged.

Fig. 6, part of the head of one of the upper windows of the towers, enlarged.

Fig. 7, a foliated heraldic panel from under the pedestals of the lower tabernacles or niches of the front, enlarged.

Fig. 8, canopies and pinnacles, &c., of the lower tabernacles, enlarged; the buttresses on which they rest are also shown at large in intercepted lengths.

Fig. 9, an enriched foliated pendent of the foregoing example, marked *a*, at a still larger scale.

Fig. 10, one of the pedestals for the reception of statues within the niches or tabernacles, enlarged.

Fig. 11, part of one of the canopies, &c., of the tower tabernacles, enlarged.

Fig. 12, one of the foliated pendents, marked *b*, of the foregoing; and fig. 13 the corbel, marked *c*, of the same, on a still larger scale.

ARCHIVE, or ARCHIVES, a chamber or apartment wherein the records, charters, and other papers and evidences, of a state, house, or community are preserved, to be consulted occasionally. Thus, we say, the *archives* of a college, of a monastery, &c.

ARCHIVIST, or ARCHIVISTA, a keeper of an archive. Under the emperors the archivist was an officer of great dignity, held equal to the proconsuls, vested with the quality of a count, styled *clarissimus*, and exempted from all public offices and taxes. Among the ancient Greeks and Persians, the trust was committed to none but men of the first rank; among the Franks, the clergy, being the only men of letters, kept the office among themselves.

ARCHLUTE, or ARCILIUTO, a long and large lute, having its bass strings lengthened after the manner of the theorbo, and each row doubled, either with a little octave or a unison. It is used by the Italians for playing a thorough bass.

ARCHON (ἄρχων), in *Ancient History*, the title of the highest magistrates at Athens. On the death of Codrus, about B.C. 1100, royalty was abolished at Athens, apparently because the ancient and venerable title of king (βασιλεύς) made the chief magistrate too independent of the nobles or *eupatrids*. Accordingly, although the highest magistracy remained hereditary in the family of Codrus, and was held for life, it was thought expedient to change its title into *Archon*, which simply signifies "a ruler." In point of fact, however, the archon's power was equal to that of a king, except that he was responsible to the nobles. The first archon was Medon, and the office remained hereditary in his family, thirteen members of which successively held it for life, until, in the year B.C. 752, the duration of the archonship was limited to ten years. But 38 years later, the exclusive right of the family of the Medontids was abolished, and the archonship thrown open to all the eupatrids without distinction. This, however, did not satisfy the nobles, as only few of them had a chance of being ever raised to the highest magistracy; and in order to increase this chance, another reform was effected in B.C. 683, by which the highest magistracy was divided among nine archons, whose office lasted only one year. The executive, which thus remained in the hands of the nobles, was now attainable to a large number of them in the course of a few years. But the abuse of their prerogatives led to reforms by which the archonship was ultimately thrown open to all the Athenian citizens indiscriminately.

The first of the nine magistrates was simply called *the archon*, sometimes with the epithet *eponymus* (ἐπώνυμος), because the year was marked by his name, as it was at Rome by the names of the two consuls. At first this archon was at the head of the whole administration; but afterwards, during the period concerning which we have authentic information, and when democracy was fully developed, his functions appear to have been limited to the superintendence of the festivals of the Dionysia and Thargelia, and of the tragic choruses and certain sacrifices. All orphans were under his especial care; and he had, lastly, jurisdiction in all matters connected with the law of inheritance. His tribunal stood near the statues of the ten archegetæ or eponymic heroes, not far from the agora, or place of the popular assemblies. The second archon bore the title of *king* (βασιλεύς); for as his functions embraced everything connected with the public worship of the gods, it would have been an act of impiety to alter his title: he was the king of the state so far as religion was concerned, just as the *rex sacrorum* was at Rome. He, in conjunction with his wife (βασίλισσα), had to perform certain sacrifices on behalf of the state, and he was especially intrusted with the superintendence of the mysteries, the festival of the Lenæa, the torch-races, and gymnic contests. In all these matters the king-archon also had jurisdiction, and his court was in the stoa βασιλέως, near the agora. He had also to act the part of public prosecutor in all offences against religion, and against murderers whose case was judged by the Areopagus. But he himself had jurisdiction in disputes about the rights and duties of priests.

The third archon bore the title of *polemarchus* (πολέμαρχος), which indicates that originally he was the supreme commander of the Athenian forces; and in this capacity we find the polemarchus Callimachus at the head of the ten Athenian generals in the battle of Marathon, B.C. 490. But afterwards we no longer hear of the polemarchus as commander-in-chief; and his functions appear to have been limited to watching

over the rights and duties of the resident aliens, just as the archon eponymus watched over those of the citizens; and arranging the funeral games in honour of those who had fallen in battle, and similar other public solemnities. His office was near the Lyceum.

Each of these three archons was entitled to appoint two assessors or assistants (πάρεδροι), who, however, had to be sanctioned, after a previous scrutiny of their character and fitness, by the senate.

The six remaining archons were called *thesmothetæ* (θεσμοθέται), a name which is sometimes applied to the whole body of the archons. But the six formed a college of justice which had to take cognizance of all cases which did not belong to the jurisdiction of any other magistrate. They appointed the jury in the popular courts, and the days on which justice was administered. They had further to see that all new laws were duly entered, and annually to revise the laws to prevent contradictory enactments being maintained at the same time. They also superintended the voting in the popular assemblies, and ratified the treaties with foreign states. Their assessors were styled symbuli (σύμβουλοι).

From these accounts it is manifest that the functions of the archons were chiefly of a judicial nature; but the legislation of Draco, and still more that of Solon, produced considerable changes, for after the institution of the Ephetæ and the popular courts, the archons, generally speaking, acted only as presidents in the various courts. In some cases, lastly, the whole college of the archons formed a court by itself, *e.g.*, to pronounce the sentence of death against an exile returning to Athens contrary to law; to try magistrates deposed by the people; to conduct the elections of the ten generals and other military officers, and the like.

Until the time of Solon, the nobles alone were eligible to the archonship; his reforms threw open the office to all persons forming the highest property-class, whether they were eupatridæ or demotæ; and Aristides eventually opened up the highest magistracy to all Athenian citizens, without any qualification either of birth or of property. During the early or aristocratic period, the archons were elected, but when democracy attained its full development, they were chosen by lot; and to prevent the honour being thus conferred on unworthy persons, the newly-chosen archons had to submit to a double scrutiny, one before the senate, which was termed ἀνάκρισις, and a second in the agora, which was called δοκιμασία. At these scrutinies they had to prove that their ancestors for three generations had been real Athenian citizens, and every archon was obliged to promise on oath scrupulously to observe the laws of the state. During their year of office all the archons were exempt from liturgies or extraordinary burdens, and any person insulting them was branded with infamy. At the expiration of their office they had to render an account of the manner in which they had discharged its duties, and when they were found blameless they became members of the high court of the Areopagus. Even at the time when Greece had completely lost its political existence, the dignity of archon was sometimes an object of ambition with men of the highest rank, and the honour was sometimes even conferred upon, and accepted by, Roman emperors. (L. S.)

Archon is also applied by some authors to various officers, civil and religious, under the eastern or Greek empire.

ARCHPRIEST, or Archpresbyter, a priest or presbyter established in some dioceses with a pre-eminence over the rest. Anciently the archpriest was next in rank after the bishop; and acted in his absence as his vicar in all spiritual matters. In the sixth century there were several archpriests in the same diocese, from which period some believe them to have been called *deans*. In the ninth century there were two kinds of cures or parishes; the smaller governed by simple priests, and the baptismal churches by archpriests, who, besides the immediate concern of the cure, had the inspection of the other inferior priests, and gave an account of them to the bishop, who governed the chief or cathedral church in person. In the Greek church, archpresbyters still exist, who are invested with most of the functions and privileges of chorepiscopi or rural deans.

ARCHYTAS *of Tarentum*, a Pythagorean philosopher, eminently skilled in mathematics and geography. He flourished in the time of Plato (B.C. 400–365), and is said to have interposed his influence with Dionysius the Tyrant, in order to save the life of that philosopher. Iamblichus is evidently mistaken when he asserts that he was a hearer of Pythagoras; and the testimony of a writer mentioned by Photius would seem more worthy of credit, that he was the eighth successive preceptor of the Pythagorean school. So eminent were his military talents, that, in opposition to an express law of his country, that no man should be chosen more than once the general of its armies, he was elevated to that station no less than seven times. He taught that there is nothing so destructive to man as pleasure; that virtue is to be pursued for its own sake, and that every extreme is incompatible with it. Aristotle, according to some, was indebted to Archytas for his general heads of classification entitled the *Ten Categories*, but this opinion has little support beyond a verbal coincidence. The discovery of the duplication of the cube by means of the conic sections, and the method of finding two mean proportionals between two given lines is due to Archytas. He is also said to have invented several curious hydraulic machines, and his genius is honoured with the invention of the screw and crane. He perished in a shipwreck, and his body was found on the Apulian coast,—an occurrence commemorated in Horace's beautiful Ode, B. i. 28. An apocryphal treatise on the Categories, bearing his name, was published by J. Camerarius at Leipsic, 8vo, 1564. A complete collection of his Fragments was published by Orelli, Leipzig, 1821, 8vo.

ARCIS-SUR-AUBE, an arrondissement in the department of the Aube, in France, extending over 539 square miles, or 344,850 acres, and containing four cantons, ninety-three communes, and in 1851, 36,364 inhabitants. The capital of the arrondissement is of the same name, and contained 2606 inhabitants. It has manufactures of cotton and of hosiery, and a considerable trade in corn by the river Aube, on the left bank of which it is situated. Long. 4. 14. E. Lat. 48. 30. N. Near this place Napoleon, on the 20th March 1814, defeated a division of the allied forces. See France.

ARCO, a strong town and castle in the Tyrol, belonging to the house of Austria. It stands on the river Sarca, near the northern extremity of the lake of Garda. Pop. 2200. Long. 10. 48. E. Lat. 45. 52. N.

ARCOLE, a village of Austrian Italy, on the Alpone, 15 miles E.S.E. of Verona, with 1600 inhabitants. At this place Buonaparte gained a victory over the Austrians on 17th November 1796. See France, and Napoleon.

ARÇON, J. C. E. Le Michaud d', a French engineer and military writer of eminence, and memorable as the inventor of the floating batteries employed against Gibraltar, was born at Pontarlier in the year 1733. He was originally destined for the church; but, instead of employing himself in the studies suited to that profession, he became wholly engrossed with plans of fortifications, and was at length admitted, with the consent of his parents, into the corps of engineers. He distinguished himself at several sieges during the seven years' war; and had acquired so much reputation by his professional services and by his writings, that he was especially employed to assist in the last grand effort made by France and Spain for the reduction of Gibraltar in 1782. It was about this period that he projected the famous floating batteries; an invention which inspired the combined armies with the greatest hopes of success, and

at first occasioned no small alarm in the British garrison. Of the ultimate fate of these expensive and formidable engines all British readers must be sufficiently informed. Not one of the whole ten escaped destruction from the bombs and red-hot balls poured upon them from the garrison. M. d'Arçon, however, published a memoir to show that his batteries were wilfully exposed to destruction through the envy and jealousy which the contrivance had excited among the Spaniards; and this statement, whatever may have been its real value, seems to have obtained the general concurrence of his countrymen.

M. d'Arçon appeared in the capacity of a general in the first years of the Revolution; and, in particular, was employed in the invasion of Holland, where, in 1793, he besieged and took several fortified places. He soon afterwards withdrew or was driven from public life, and remained in retirement till 1799, when he was made a member of the Conservative Senate by Buonaparte. He died the following year, aged sixty-seven.

ARCOS DE LA FRONTERA, a Spanish town in the province of Cadiz, between Ronda and Santa Maria. It is situated on the banks of the river Guadalete, celebrated for that decisive battle of three days' continuance, near Xerès, by which the crown of the Gothic kings of Spain was transferred to the Arabian invaders. It contains two parish churches, seven monasteries, 1334 houses, and 12,000 inhabitants. Long. 5. 55. W. Lat. 36. 39. N.

ARCOT, a city of Hindustan, capital of a district of the same name, is situated on the S. side of the river Palar. Arcot is supposed to have been the capital of the Soræ, or the Soramundalum of Ptolemy, whence, by an easy derivation, Coromandel; but the present town is entirely of modern date. The Mogul armies, after they had captured Gingee, found the situation so unhealthy that they were forced to remove to the plains of Arcot, and began to build the present town about the year 1716. The nabob of Arcot, Anwanud Deen, being killed in battle in 1749, the place was taken by his competitor, who was supported by the French. In 1751 it was retaken by Colonel Clive, with 500 troops, from a garrison of 1100 men; and here that gallant soldier maintained himself for fifty days against the attacks of the French and their Indian allies, who were finally compelled to raise the siege. It was afterwards taken by the French, but was recaptured in 1760 by Colonel Coote, after the battle of Wandewash. Hyder Ali gained possession of it for a time after he had defeated the British under Colonel Baillie in 1780. Long. 79. 25. E. Lat. 12. 56. N.

ARCTIC, in *Astronomy*, an epithet given to the north pole, or the pole raised above our horizon. It is called the *arctic pole*, from the constellation of the little bear; called in Greek, ἄρκτος, the last star in the tail of which nearly points out the north pole.

ARCTIC *Circle* is a lesser circle of the sphere, parallel to the equator, and 23° 30′ distant from the north pole; from whence its name. This, and its opposite the *antarctic*, are called the two *polar circles*, and may be conceived to be described by the motion of the poles of the ecliptic round the poles of the equator, or of the world.

ARCTIC REGIONS. See POLAR REGIONS.

ARCTURUS, in *Astronomy*, a fixed star of the first magnitude, in the constellation Arctophylax, or Bootes. The word is formed of ἄρκτος, *bear*, and οὐρά, *tail*, *bear's tail*, in reference to its position.

ARCY, GROTTE D', a vast stalactitic cavern in the French department of Yonne, divided into many compartments, one of which is 1200 feet long, 85 feet high, and 40 feet wide.

ARCY, PATRICK D', member of the Academy of Sciences of Paris, a general officer in the French army, Chevalier of the order of St Louis, &c., was born in Ireland in 1725. His parents, in consequence of their attachment to the house of Stuart, left Ireland, and settled in France. He studied mathematics with distinguished success under Clairaut the elder, and had for his fellow-student the celebrated Clairaut the son. He obtained a commission in the French army, and in 1746 was embarked in the expedition which was intended to make a descent into Scotland. He was made prisoner, and was treated like other prisoners of war, no notice being taken of his having been born a British subject. He continued attached to the house of Stuart during the whole of his life.

In 1760 he published his *Essay on Artillery*. To estimate the force of the explosion of gunpowder, he employed a cannon suspended so that the arc of vibration described by it on its being fired was a measure of the force of explosion. To measure the initial velocity of a projectile, he used Robins's machine. Robins showed, that when the velocity of a projectile is great, the resistance opposed by the air is not in proportion to the square of the velocity, as is the case when the velocity is small. D'Arcy made experiments with a view of ascertaining this law, but without success. His work contains an account of experiments made by him to determine the most advantageous length of cannon. He published a paper on hydraulic machines in 1754, where he treats of the maximum of effect of water-wheels. He also published a paper concerning the duration of the impression of light on the retina. He found that the revolution of a luminous point must be rapid, so as to be performed in $\frac{8}{60}$ths of a second at the least, in order to produce the appearance of a continued luminous circle.

D'Arcy was of a handsome figure, and passed much of his time in the gay world. A short time before his death, he married a young lady, his niece, and took the title of Count. He died in 1779. (W. A. C.)

ARDEA, or ARDUA, a very ancient city of Latium, the capital of the Rutuli, on the river Numicus. It is now a village with 200 inhabitants, in the midst of pestilential swamps.

ARDEBIL, or ARDEBEEL, a town of Persia, in the province of Azerbijan, on a river which runs into the Aras or Araxes. It is situated on the southern side of the desert plain of Ardebil, which is 60 miles in length by 40 in breadth. The town contains about 500 or 600 families, and appears to have been built from some former city. It is surrounded by a ruinous wall of mud, flanked with towers in a like state of decay. It has a fort, which is a regular square, with bastions at the corners, fortified according to the European fashion. The only objects of interest are the tombs of Sheik Suffee, the ancestor of the Suffanean kings, and his descendants. It is still held in veneration as having been the residence of that prince.

ARDÈCHE, a department in the south of France, formerly Vivarais. The granitic chain of the Cevennes occupies a large part of it. The culminating point of that group is 5970 feet above the sea, and is named Mount Mezen. Sandstone forms the lower portions of the district, over which lie beds of a coal formation, limestone, and chalk; but the continuity of these beds is disturbed by the cones of extinct volcanoes, part of the remarkable belt that passes from Puy de Dôme, through Cantal and Haute Loire, towards the Rhone at Rochemaure. The surface = 2081 square miles; and the population, by the census of 1851, 386,505. The department contains three arrondissements; Tournon, Largentière, and Privas. Its chief rivers are the Rhone, Loire, Cance, Doux, Erieux, and Ardèche. The mineral products are iron, antimony, coal, &c. Wine, chesnuts, and olives, are abundant, but corn is rather deficient. The mulberry is much cultivated for the rearing of silkworms.

ARDEE, a town of Ireland, county of Louth, on the river Dee, whence its ancient name of Atherdee, "Town on the Dee." It was formerly a place of considerable importance, but now consists chiefly of miserable cabins. It has two old

castles, one of which is used as a court-house; a church of the thirteenth century; a large Roman Catholic chapel; savings bank; dispensary; and several schools. It has a considerable malt and corn trade. Pop. in 1851, 2752.

ARDELAN, a province of Persia, which forms the eastern division of Kurdistan. Its length is 200 miles, and its breadth about 160. It is divided from the plain of Hamadan by a small range of hills, and its western boundary is 100 miles beyond Senna, the capital, which is situated in Long. 40. E. and Lat. 35. 12. N., 60 miles from Hamadan. From the Sharook, which separates the province from Azerbijan, to Senna, the country presents either a succession of hills clustered and heaped together, or great table-lands covered with the flocks and tents of wandering shepherds, who pass the summer here, and migrate in the winter to the vicinity of Baghdad. The soil in the valleys or glens, which are narrow strips at the foot of the mountains, is fertile, and yields abundance of wheat and barley. The oil plant, *Sesamum orientale*, is everywhere cultivated, and also tobacco, though in small quantities. The deep valley in which the capital is situated is well cultivated, and interspersed with orchards of fruit-trees. The mountains to the west are covered with forests of oak, which produce fine timber, and abundance of gall-nuts, which are exported to India, while the oak is floated down the Tab into the Tigris. The inhabitants, and other pastoral and rude tribes, make little use of the natural advantages of the country, being addicted to war, cruelty, and rapine. There is another tribe of shepherds named Gheshkee, who are most expert and daring robbers. These tribes are under the government of a powerful chief, who pays an annual tribute to Persia, but is in all other respects independent. He rules over his vassals with the most absolute power, but is said to govern rather like a patriarch than a tyrant.—*Kinneir*.

ARDELL, James Mac, one of the ablest of mezzotinto engravers, is supposed to have been born in Ireland about 1711. His chief works are portraits of distinguished persons after Hogarth, Hudson, Reynolds, and others; and a few historical subjects after Vandyk, Murillo, and Rembrandt. He resided at London, and died there in 1765.

ARDEN, Arduen, or Ardven, the common name of forests among the Celts. It is written *Arduen* by Cæsar and Tacitus in speaking of the forest in Gaul.

ARDENNE, Forest of (the *Sylva Arduenna* of the Romans), an extensive woody and mountainous district in the north of France, stretching also into Belgium and the Grand Duchy of the Lower Rhine. It extends westward to the sources of the Somme, Oise, Sambre, and Scheldt, and eastward to the valley of the Moselle. In Cæsar's time it extended to the Rhine. Its average elevation is about 1700 feet: some of its peaks attain a height of 2500.

ARDENNES, a frontier department in the north-east of France, deriving its name from that of the celebrated forest. It is bounded on the north by Belgium; and on the west, south, and east, by the departments of Aisne, Marne, and Meuse, respectively. It is mostly mountainous, the northern part abounding with forests; and the climate is generally cold and humid. The only navigable rivers are the Meuse and Aisne, which are united by the canal of Ardennes. Of the tributaries of the Meuse in this department, the principal are the Chiers, Semoy, Bar, Vence, and Sermonne; those of the Aisne, the Aire, Vaux, and Retourne. Ardennes is celebrated for its sheep. Its woods abound in game, and its rivers in fish. Agriculture has recently made considerable progress in this department, nearly three-fourths of it being now under cultivation: the inhabitants are chiefly occupied in raising corn, and make but little wine. The country is rich in minerals, particularly in iron, lead, slate, and marble. The principal manufactures are cloths; iron, copper, and zinc goods; earthenware, glass, leather, and beer. It has an area of 517,385 hectares, or 1,278,530 acres; and is divided into five arrondissements, viz., Mezières, Rethel, Rocroy, Sedan, and Vouziers; comprehending 31 cantons and 478 communes. Pop. in 1851, 331,296. Its capital is Mezières.

ARDES, a town of France, in Lower Auvergne, and now in the department of Puy de Dôme. It serves as a mart for the trade between Upper and Lower Auvergne. Pop. 1773.

ARDFERT, a town of Ireland, in the county of Kerry, of which it was formerly the capital, though it is now a ruinous and decayed village. It had at one time a university, and was a bishop's see; but it is now united to that of Limerick. Here are several religious edifices. A pillar tower, which stood near the cathedral, and was one of the loftiest and finest in the kingdom, fell in 1780.

ARDGLASS, a seaport town of Ireland, county of Down, six miles south-east of Downpatrick, was formerly a place of considerable importance. Population in 1851, 974, chiefly engaged in the fisheries. It is much frequented by visitors during the bathing season. Vessels of 500 tons may enter the outer harbour at all tides, and its inner cove admits vessels of 100 tons. There is a lighthouse at the extremity of the pier in Lat. 54. 15. N. Long. 5. 36. W.

ARDISHEER, the founder of the Sassanian dynasty of Persia, called by the Romans Artaxerxes. See Persia.

ARDOCH, a parish in Perthshire, celebrated for a very perfect Roman camp, or large fort, with five ramparts and as many ditches, inclosing an area of 100 by 86 yards. See Gordon, *Itiner. Septent.*, Pennant's *Tour*, iii. 102. Adjoining, also, are remains of two Castra Æstiva, one of which is 953 by 650 yards, another 635 by 445 yards. General Roy considers these stations as the position of Agricola, before dividing his army into three bodies, when he marched against the Caledonii.

ARDOYE, a market-town of Belgium, in the province of West Flanders, and arrondissement of Roulers. Pop. in 1851, 6142.

ARDRAH, formerly an independent territory of Africa, on the slave coast of Guinea, but now a province of the kingdom of Dahomey. Its chief town, of the same name, is about forty miles inland, and has a population of 8000.

ARDRES, a town of France, in Pas de Calais. Here an interview took place between Francis I. and Henry VIII. king of England in 1520. It is eight miles south of Calais.

ARDROSSAN, a seaport town of Ayrshire, Scotland, situated on the Firth of Clyde opposite the island of Arran, and 16 miles north-west of Ayr. The town has lately been much improved, and is a favourite resort of visitors during the bathing season. Large sums were expended by the late Earl of Eglintoun in forming the harbour, which is sheltered by a pier and a small islet, and has a lighthouse with a fixed light on the north-east breakwater, in Lat. 55. 38. 27. N. Long. 4. 49. 28. W. It has a branch railway uniting it with the Glasgow and Ayr lines at Kilwinning, and communication by steamers with Arran, Belfast, and Liverpool. Pop. in 1851, 2071. See Ayrshire.

ARDSISCH, a town in the province of Wallachia, on a small river of the same name, which falls into the Danube. It was once the seat of government, but is fast decaying. It still contains six churches, a large and beautiful monastery, and the ruins of the ancient palace of the sovereigns.

ARE, the present French superficial measure, is a square, of which the sides = 10 metres. A metre = 39·37079 inches; and 100 ares or 1 hectare = 2·4711695 English acres; or 202½ hectares = 500 English acres.

AREA, in general, denotes any plain surface. The Latin word more properly denoted a threshing floor; and is derived from *arere* to be dry.

Area, in *Architecture*, denotes the space or site of ground on which an edifice stands. It is also used for inner courts and other inclosed spaces.

Area, in *Geometry*, denotes the superficial content of any figure. Thus, if a figure, *e. g.*, a field, be in form of a square, and its side be 40 feet long, its area is said to be 1600 square feet; or it contains 1600 little squares, each a foot every way.

AREBO, a considerable town of Benin, in Africa, on the river Formosa. Long. 5. 8. E. Lat. 5. 58. N.

ARECA, a genus of palms, two of which are remarkable. *A. oleracea* is the *cabbage palm* of the West Indies and Guyana, which attains a height of from one to two hundred feet, with a very slender stem, of only a few inches in diameter. It is felled to obtain the young shoots, which are eaten as a vegetable, especially in pickles; the nuts are sweet and edible, and the trunk forms excellent water-pipes, when its soft interior decays. *A. Catechu* is the well-known *Betel Palm* of India; the astringent kernels are universally chewed in the East, when mixed with the leaf of a sort of pepper and quick lime. This pepper is the *Piper Betle* of botanists. The nuts are also used to afford an inferior sort of catechu, named *Kassu*, and *Coury*, now seldom imported into Europe.

AREMBERG, a small market-town of Prussia, government of Coblenz, circle of Adenau, with 300 inhabitants. It is situated on the river Aar, and has a castle, the ancient residence of the dukes of Aremberg, who thence derived their title. About the year 1298, the earldom of Aremberg came by marriage to John of Engelbert, earl of Mark, in whose family it continued till 1547, when John of Barbançon, of the celebrated house of Ligne, by marrying the only daughter of the last earl, obtained possession of the lands. In 1572 it was raised to a principality, and ranked among the German States. In 1582, the prince obtained a seat in the diet; and Prince Philip Charles, who died in 1616, by marrying Ann of Croy obtained the possessions of the duke of Croy and Arschot. In 1644 Philip Francis, then the reigning prince, received the title of duke. By the peace of Luneville concluded in February 1801, between Austria, in the name of the German empire, and France, by which Belgium and the territory on the left bank of the Rhine were ceded to France, the duke lost the greater part of his possessions, and received as compensation the territories of Recklinghausen and Meppen. On the establishment of the confederation of the Rhine, the duke became a member of that body; but in 1810 he lost his sovereignty by Napoleon's incorporating his dukedom with France and the grand duchy of Berg, for which he received a rent of 240,702 francs, and remained in possession of his domains. In 1815 the duke received back his possessions, which, at the Congress of Vienna, were mediatized, a part to Prussia, and a part to Hanover. On account of the former, he became a peer of the Westphalian Estates; and, by the latter, a member of the House of Lords in Hanover. George IV., on 9th May 1826, elevated the duke's possessions in Hanover to a dukedom, under the title of Aremberg-Meppen. The present duke is also a grandee of Spain of the first class. His German possessions extend over about 780 geographical square miles, with 94,000 inhabitants; of which, 544 square miles, with 50,000 inhabitants, are in Hanover; besides which he has large estates in France, and extensive tracts of forest in the Pyrenees. The present duke resides at Brussels; and his income from all his estates is about 750,000 guilders, or L.62,500.

ARENA, in *Roman Antiquity*, the place where the gladiators fought; so called from its being strewed with sand, in order to conceal from the view of the spectators the blood spilt in the combat. Caligula, Nero, and others, are said to have strewed the arena with a golden dust (probably cinnabar) and with borax. An interesting description of the several games of the amphitheatre is given in the Eclogues of Calpurnius. (Edited by Glaeser, *Gotting*. 1842.)

ARENARIA, a genus of wading birds, to which our Redshank belongs.

Arenaria, a genus of plants of the natural order of Caryophylleæ, containing numerous species, of which ten are known in Britain, under the name of *sandworts*.

ARENARII, in *Antiquity*, gladiators who combated in the arena or amphitheatre.

ARENARIUM, in *Ecclesiastical Writers*, denotes a cemetery or burying-ground. The arenaria were properly a kind of pits or holes under ground, in which the ancient Christians not only buried their dead, but held their religious assemblies in times of persecution.

ARENDAL, a seaport town of Norway, on the Skagerrack, 35 miles north-east of Christiansand. Lat. 58. 27. N. Long. 8. 50. 25. E. It has a considerable shipping trade, particularly in iron and timber. Population, 3229, engaged in the distilleries, tobacco factories, dockyards, and in the iron mines around. The vicinity is remarkable for the number of beautiful and rare minerals found there.

ARENDT, Martin Frederic, a learned antiquary born at Altona in 1769. In 1798 he commenced his travels in pursuit of antiquarian lore, visiting the northern parts of Europe, and afterwards Spain, Italy, and Hungary. His peregrinations were performed entirely on foot; he frequently slept in the open air, and trusted for subsistence to the bounty of strangers. He made accurate observations on the antiquities of the countries through which he passed, and published a few memoirs; but much of his erudition, which was undoubtedly great, has perished with himself. A part of his papers and drawings were deposited in the library at Copenhagen. He died in prison at Naples in 1824.

ARENG, Labillardiere's designation of a genus of palms, known in Sprengel's work by the name of *Gomutus*, originally proposed for it by Rumphius. It contains only a single species, *G. saccharifer*. Its juice, when fermented, is palm wine, which is astringent and intoxicating. The trunk of this palm rises to the height of 25 or 30 feet, is covered with the coarse, black fibres, of which the Indians make cables; and from it a large quantity of farinaceous matter is obtained, which is manufactured into a species of sago. The sap as it flows from the plant is a pale, yellowish, transparent liquid, which is generally collected in gourds, or joints of the large bamboo tied to the cut midribs of the leaves. The plant is a native of Cochin-China and the Indian Isles.

ARENSBERG, or Arnsberg, a city of Westphalia, in Prussia, the chief town of a government and circle of the same name. It is situated on an eminence almost surrounded by the River Ruhr, 44 miles south-east of Munster, and 58 miles E.N.E. of Dusseldorf. It is the residence of the provincial authorities, and has a court of appeal, a catholic gymnasium, and a society of agriculture. Pop. 4438. Arensberg was the capital of the ancient Duchy of Westphalia, and was formerly a member of the Hanseatic league. Near the town are the ruins of an ancient castle, once the residence of the earls of Arnsberg; the last of whom, Gottfried, sold his earldom, in 1368, to the archbishop of Cologne.

ARENSBURG, a seaport town of European Russia, capital of the Island of Oesel in the Baltic, at the mouth of the Gulf of Riga. It is situated on the south side of the island, in Lat. 58. 15. N. Long. 22. 18. E. Pop. 1600. From the shallowness of its harbour, vessels are obliged to anchor in the roads, about five miles west of the town.

AREOLA, in *Anatomy*, the coloured circle surrounding the nipple of the breast.

AREOPAGUS, the highest tribunal at Athens, famous for the justice and impartiality of its decrees, to which the gods themselves are said to have submitted their differences. See Attica.

AREQUIPA, the most southern of the seven departments into which the republic of Peru is divided. It lies along the Pacific between Lat. 15. and 21. S. and Long. 69. and 75. W.; having on the north the departments of Lima,

Ayacucho, and Puno; and on the east and south, Bolivia. Its chief productions are silver, nitrate of soda, guano, sheep, alpaca wool, sugar, wine, and brandy. It is divided into seven provinces. The chief town of the department has the same name, and lies in the fertile valley of Quilca, 7775 feet above the level of the sea, in Lat. 16. 30. S. Long. 71. 48. W. This city is handsome and well built, with a cathedral, a college, a hospital, several nunneries and convents, and a bronze fountain in its great square. It has a very considerable trade, with manufactures of woollen and linen goods, and gold and silver ornaments. It is subject to frequent earthquakes; but the climate is mild and salubrious. Behind the city rise three lofty mountains, one of which, called the peak of *Misté*, is an active volcano, and rises to the height of 18,373 feet. Pop. 20,000.

ARES (Ἄρης), son of Zeus and Hera, the god of war among the Greeks, identified by the Romans with their own Mars. From this word was derived ἀρετή, *virtue*, as also ἀρείων, ἄριστος, &c., the earliest idea of excellence being connected with martial superiority.

ARETÆUS *of Cappadocia*, a Greek physician of the sect of the Pneumatists, who, according to some, lived in the reign of Augustus; according to others, under Trajan or Hadrian. He wrote, in the Ionian dialect, several treatises on acute diseases and other medical subjects, some of which are still extant. The best edition of his works is that of Boerhaave, in Greek and Latin, with notes, printed in 1731; that printed at Oxford in 1723, in folio, is also much esteemed: and an excellent edition by C. G. Kühn, was published at Leipzig in 1828.

ARETALOGI, in *Antiquity*, a class of philosophers, chiefly of the Cynic or Stoic school, who frequented the tables of great men, and entertained them at their banquets with disputations on virtue, vice, and other popular topics. These are sometimes also denominated *Circulatores Philosophi.* Such a mode of life would naturally degenerate into that of the parasite and buffoon; hence they are mentioned with contempt by Juvenal, *Sat.* xv.

ARETHUSA, a celebrated fountain near the city of Syracuse, in Sicily, famous for the quantity of its waters, and the number of fishes it contained. Many fables were invented by the ancients concerning this fountain. It was said to have derived its name from Arethusa, the daughter of Nereus and Doris, and the companion of Artemis (Diana), who changed her into a fountain to deliver her from the pursuit of her lover Alpheus. It was also believed that the river Alpheus ran under or through the waters of the sea, without mixing with them, from Peloponnesus to Sicily. Mr Brydone informs us that it still continues to send forth an immense quantity of water, rising at once to the size of a river, but is entirely abandoned by the fishes it formerly contained in such plenty. Mr Swinburne describes this once famous fountain as a large pool of water near the quay, defended from the sea by a wall, and almost hidden by houses on every other side. The water is not salt but brackish, and fit for no purpose but washing linen. "Such," says he, "is the celebrated fountain of Arethusa, whose soft, poetical name is known to every reader."

ARETINO, GUIDO, famous for his improvements in music, lived in the eleventh century. He was born in the city of Arezzo, in Tuscany; and having been taught the practice of music in his youth, and being probably retained as a chorister in the service of the Benedictine monastery founded in that city, he became a monk professed, and a brother of the order of St Benedict.

In this retirement he seems to have devoted himself to the study of music, particularly the system of the ancients, and, above all, to reform their method of notation. The difficulties that attended the instruction of youth in the church offices were so great, that, as he himself says, ten years were generally consumed barely in acquiring the knowledge of the plain song; and this consideration induced him to labour after some amendment,—some method that might facilitate instruction, and enable those employed in the choral office to perform the duties of it in a correct and decent manner. Were we to credit those legendary accounts that are extant in old monkish manuscripts, we should believe he was assisted in his pious intention by immediate communications from heaven. Some speak of the invention of the syllables as the effect of inspiration; and Guido himself seems to have been of the same opinion, by his saying it was revealed to him by the Lord, or, as some interpret his words, in a dream. Graver historians say, that being at vespers in the chapel of his monastery, it happened that one of the offices appointed for that day was the hymn to St John,—

UT queant laxis   *REsonare fibris*
MIra gestorum   *FAmuli tuorum*
SOLve polluti   *LAbii reatum,*
Sancte Joannes!

During the performance of the hymn, he remarked the iteration of the words, and the frequent returns of UT, RE, MI, FA, SOL, LA. He observed likewise a dissimilarity between the closeness of the syllable MI and broad open sound of FA, which, he thought, could not fail to impress upon the mind a lasting idea of their congruity; and immediately conceived a thought of applying these six syllables to perfect an improvement either then actually made by him, or under consideration, viz., that of converting the ancient tetrachords into hexachords.

Struck with the discovery, he retired to his study, and having perfected his system, began to introduce it into practice. The persons to whom he communicated it were the brethren of his own monastery, from whom it met with but a cold reception, which he ascribed to envy. However, his interest with the abbot, and his employment in the chapel, gave him an opportunity of trying the efficacy of his method on the boys who were training up for the choral service, and it exceeded the most sanguine expectation. "To the admiration of all," says Cardinal Baronius, "a boy thereby learnt, in a few months, what no man, though of great ingenuity, could hitherto acquire in several years."

The fame of Guido's invention soon spread abroad, and his method of instruction was adopted by the clergy of other countries. We are told by Kircher, that Hermannus bishop of Hamburgh, and Elviricus bishop of Osnaburg, made use of it; and by the authors of the *Histoire Littéraire de la France*, that it was received in that country, and taught in all the monasteries in the kingdom. It is certain that the reputation of his great skill in music had excited in the pope a desire to see and converse with him; of which, and of his going to Rome for that purpose, and the reception he met with from the pontiff, he himself has given a circumstantial account in the epistle hereafter mentioned.

It seems that John XX., or, as some writers compute, the nineteenth pope of that name, having heard of the fame of Guido's school, and conceiving a desire to see him, sent three messengers to invite him to Rome. Upon their arrival, it was resolved by the brethren of the monastery that he should go thither attended by Grimaldo the abbot, and Peter the chief of the canons of the church of Arezzo. Arriving at Rome, he was presented to the holy father, who received him with great kindness, and honoured him with several interviews, during which he interrogated him as to his knowledge in music; and upon sight of an antiphonary which Guido had brought with him, marked with the syllables according to his new invention, the pontiff looked upon it as a kind of prodigy, and ruminating on the doctrines delivered by Guido, would not stir from his seat till he had learned perfectly to sing off a verse; upon which he declared that he could not have believed the efficacy of the method,

if he had not been convinced by the experiment he had himself made of it. The pope would have detained him at Rome; but labouring under a bodily disorder, and fearing an injury to his health from the air of the place, and the heats of the summer, which was then approaching, Guido left that city upon a promise to revisit it, and explain to his holiness the principles of his new system.

On his return home he visited the abbot of Pomposa, a town in the duchy of Ferrara, at whose request he took up his abode in the monastery. Here he composed a tract on music, entitled *Micrologus*, i. e., a short discourse, which he dedicated to Theobald, bishop of Arezzo; and finished, as he himself at the end of it tells us, under the pontificate of John XX., and in the 34th year of his age. Vossius speaks also of another musical treatise written by him, and dedicated to the same person. Most of the authors who have taken occasion to mention Guido, speak of the Micrologus as containing the sum of his doctrine; but it is in a small tract, entitled *Argumentum novi Cantus inveniendi*, that his declaration of his use of the syllables, with their several mutations, and in short his whole doctrine of solmization, is to be found. This tract forms part of an epistle to a very dear and intimate friend of Guido, whom he addresses thus, "Beatissimo atque dulcissimo fratri Michaeli," at whose request the tract itself seems to have been composed.

Whether Guido was the author of any other tracts is not easy to determine. It nowhere appears that any of his works were ever printed, except that Baronius, in his *Annales Ecclesiastici*, tom. xi. p. 73, has given at length the epistle from him to his friend Michael of Pomposa, and that to Theobald, bishop of Arezzo, prefixed to the Micrologus; and yet the writers on music speak of the Micrologus as of a book in the hands of every one. Martini cites several manuscripts of Guido; namely, two in the Ambrosian library at Milan, the one written about the twelfth century, the other less ancient; another among the archives of the chapter of Pistoja, a city in Tuscany; and a third in the Medico-Laurenziano library at Florence, of the fifteenth century: these are clearly the Micrologus. Of the epistle to Michael of Pomposa, together with the *Argumentum novi Cantus inveniendi*, he mentions only one, which, he says, is somewhere at Ratisbon. Of the several tracts above mentioned, the last excepted, a manuscript is extant in the library of Baliol College, Oxford. (See Kiesewetter *Hist. of Music;* translated by Robert Müller: London, 1848, chap. ii.)

Aretino, *Leonardo*, one of the most learned men of the fifteenth century, was secretary to the republic of Florence, and translated from the Greek into Latin some of the Lives of Plutarch, and Aristotle's Ethics. He also composed three books of the Punic war, as a supplement to those wanting in Livy; the history of the transactions in Italy during his time; that of ancient Greece; that of the Goths; that of the republic of Florence; and many other works. He died in 1443, aged 74.

Aretino, *Francesco*, a man of great learning, and well acquainted with the Greek language. He translated into Latin the Commentaries of St Chrysostom upon St John, and about twenty homilies of the same father; he also translated the Letters of Phalaris into Latin, and wrote a treatise *De Balneis Puteolanis*. He studied at Sienna about the year 1443, and afterwards taught law there with such reputation that he was called the *Prince of Subtleties*. He taught also in the university of Pisa, and in that of Ferrara.

Aretino, *Pietro*, a native of Arezzo, who lived in the sixteenth century. He was famous for his satirical writings; and was so bold as to direct his invectives even against sovereigns, and from thence got the title of the *Scourge of Princes*. Francis I., the Emperor Charles V., most of the princes of Italy, several cardinals, and many noblemen, courted his friendship by presents, either because they liked his compositions, or perhaps from an apprehension of falling under the lash of his satire. Aretino became so insolent, that he is said to have got a medal struck, on one side of which he is represented, with these words, *Il divino Aretino;* and on the reverse, sitting upon a throne, receiving the presents of princes, with these words, *I principi tributati da popoli, tributano il servidor loro*. Some imagine that he gave himself the title of *Divine*, signifying thereby that he performed the functions of a god upon earth, by the thunderbolts with which he struck the heads of the highest personages. He used to boast that his lampoons did more service to the world than sermons; and it was said of him, that he had subjected more princes by his pen than the greatest had ever done by their arms. Aretino wrote many irreligious and obscene pieces; such are his dialogues, called *Ragionamenti*. There is likewise imputed to him another very obscene performance, *De omnibus Veneris schematibus*. "It was about the year 1525 (says M. Chevillier, *Origine de l'Imprimerie de Paris*, p. 224) that Julio Romano, the most famous painter of Italy, instigated by the enemy of the salvation of mankind, invented drawings for 20 engraved plates; the subjects are so immodest that I dare only name them. Pietro Aretino composed sonnets for each figure. George Vasari, who relates this in his *Lives of Painters*, says he does not know which would be the greatest impurity, to cast one's eyes upon the drawings of Julio, or to dip into the verses of Aretino." Some say that Aretino changed his libertine principles; but however this may be, it is certain that he composed several theological or pious pieces. He wrote a paraphrase on the penitential psalms, and another on Genesis; the Life of the Virgin Mary, and that of St Catharine of Sienna, and of St Thomas Aquinas. His familiar Letters were collected and published at Paris, in 6 vols. 8vo, 1609. He was author likewise of various poetical pieces, among which is a tragedy on the subject of the Horatii, possessed of considerable merit. He died in the year 1556, at the age of 65.

AREZZO (the ancient *Arretium, Arretinus*, or *Aretinus*), a city of Tuscany, capital of a province of the same name, situated on the Chiano, an affluent of the Arno, 40 miles south-east of Florence. Lat. 43. 18. 6. N. Long. 11. 53. 35. E. It is the seat of a bishop and of a court of appeal; and has a magnificent cathedral of the thirteenth century with some fine monuments, many churches and cloisters, several educational institutions, a surgical school, hospital, library, and museum. In the principal square stands a magnificent building called Le Loggie, containing the custom-house, the theatre, town-hall, &c., with a portico 400 feet in length. Its principal manufactures are woollen stuffs and pins. Pop. 9500. Arezzo is the birthplace of many eminent persons, among whom were Mæcenas, Petrarch, Vasari, Bracci, Leonard Bruin, called Aretin, Guido the great improver of musical notation, and the naturalist Redi.

Arretium was one of the most ancient and powerful of the Etruscan cities. History is silent as to the period when it became subject to the Roman sway; but after the conquest of Italy, Arretium was a military post of the highest importance to the Romans, as commanding the western entrance into Etruria, and the valley of the Tiber from Cisalpine Gaul; and here Flaminius was posted with his army to oppose the advance of Hannibal in the second Punic war. On the commencement of the civil war in B.C. 49, this was one of the first places that Cæsar occupied after crossing the Rubicon. The only ancient remains in Arezzo are some small portions of a Roman amphitheatre; and hence some suppose that the modern city occupies the site of the Roman Arretium, but that the ancient Etruscan city of that name was distant two or three miles to the south-east, where some remains of what are called cyclopean walls are still visible. Many valuable relics of antiquity have been found at Arezzo, among which are numerous works in bronze, especially the

Chimæra and the statue of Minerva, which are now preserved in the gallery at Florence.

Pliny informs us that its pottery was celebrated; and many specimens have been found there of a peculiar red ware figured in relief, wholly different from the painted vases of southern Etruria and Campania.

ARFE, HENRIQUE, and JUAN DE, two celebrated artists in silver of the times of the Emperor Charles V., and King Philip II. of Spain. The magnificent *custodia* or tabernacle for the host, on the altars of several of the Spanish cathedrals, as at Sevilla, Cordova, and Toledo, &c., are by them. The designs are architectural, with many well-engraved figures, and an idea may be formed of their size, from their each consisting of from six to eight cwt. of pure silver. The first artist was grandfather of the second.

ARGAND, AIMÉ, a Genevese, who, about 1782, invented the lamp known by his name. It has a hollow wick, so as to admit air to both surfaces of the flame, by which the heat and light are much increased. Until the coal-gas lamp was known, the argand lamp was much used by chemists, and also for illuminating houses. It has also been employed in gas-burners, but consumes much gas.

ARGAUM, in Southern India, a village of Hyderabad, or the territory of the Nizam This place is celebrated for the battle fought on the 28th November 1803, between the combined forces of Scindia and the Rajah of Berar, and the British army under the command of Major General Wellesley (afterwards Duke of Wellington), in which the Mahrattas were defeated with great loss. A medal struck in England in 1851 commemorates the victory. Distant south-west from Ellichpoor 40 miles, north-east from Aurungabad 135. Lat. 21. 2. Long. 77. 2. (E. T.)

ARGEI, or ARGÆI, in *Roman Antiquity*, thirty human figures made of rushes thrown annually by the priests or vestals into the Tiber on the day of the ides of May. According to Dionysius of Halicarnassus, this custom was instituted to satisfy the scruples of the people when human sacrifices to Saturn were abolished by Hercules. (*Antiq. Rom.* i. 19, 38.)

ARGELES, an arrondissement in the department of the Upper Pyrenees, in France, extending over 523 square miles, or 334,698 acres. It is divided into five cantons, and subdivided into 99 communes. Pop. in 1851, 42,558. The chief city of the arrondissement, of the same name, is situated in the beautiful valley of Lavedan, on the banks of the Gave d'Azun.

ARGENSOLA, BARTOLOME LEONARD DE, a native of Barbastro in Aragon, born in 1566. He studied at the university of Huesca, embraced the ecclesiastical profession, and became chaplain to Doña Maria of Austria. He was the continuator of the *Anales de Aragon* of Zurita, the author of a history of the conquest of the Molucca Isles, besides some poetical effusions, all which are commended by Bouterwek for elegance and correct purity of style. His elder brother, Lupercio, was secretary to the Conde de Lemos, when viceroy of Naples, and left behind him poetic works of merit not yet published. (Bouterwek, *Geschichte.*)

ARGENT, the common French word for *silver.* It is used in heraldry to signify purity, beauty, and gentleness.

ARGENTAC, or ARGENTAT, a town of France, in the department of Correze, on the river Dordogne. Pop. 2076. In the vicinity are mines of coal and lead.

ARGENTAN, an arrondissement in the department of the Orne, in France, extending over 729 square miles, or 466,690 acres. It comprehends 11 cantons, divided into 190 communes. Population in 1851, 106,854. The chief city of the arrondissement is of the same name. It is situated on an elevation in a beautiful plain, through which the Orne runs. It contains 5425 inhabitants, who manufacture thread-lace of a fine quality, some linen goods, and leather. Long. 0. 2. W. Lat. 48. 44. N.

ARGENTARIUS is frequently used in Roman Wr[illegible]rs for a money changer or banker. The argentarii were capitalists, who made a profit either by the changing or lending of money at interest. They had their *tabernæ* or offices. in the *forum Romanum*, built there as early as the reign of L. Tarquinius Priscus.

ARGENTEUIL, a small town of France, in the department of Seine and Oise, and capital of a canton. It stands on the Seine, 11 miles north-east of Versailles. Pop. 4569. It was to a nunnery in this town that Heloise retired after the misfortune of Abelard. See ABELARD.

ARGENTIERE, or CIMOLI, the ancient Κίμωλις, one of the Cyclades, is about 18 miles in compass, and very mountainous. Pop. 800. The *Cimolia terra* of antiquity is still found here, and is formed into cakes, which are stamped with the seal of the Grand Seignior. See CIMOLIA TERRA.

ARGENTINE CONFEDERATION. See PLATA, LA.

ARGENTINUS, a deity worshipped by the Romans as the god of silver coin; as Æsculanus, whom they made his father, was the god of brass money, which was in use before silver.

ARGENTUM ALBUM, in our old customs, silver coin, or pieces of bullion, that passed for money.

ARGENTUM *Dei, God's penny*, anciently signified earnest money, or money given to bind a bargain; in some places called *erles* or *arles*, and by the civilians and canonists *arrhæ.*

ARGO, in *Antiquity*, the ship celebrated in ancient poetry as that in which the Argonauts made their expedition to Colchis in quest of the golden fleece. Jason having happily accomplished his enterprise, consecrated the ship Argo to Poseidon (Neptune), or, as others say, to Athena (Minerva), on the isthmus of Corinth, where, they add, it did not remain long before it was translated into heaven, and made a constellation.

ARGOBAST, LOUIS FRANÇOIS ANTOINE, a distinguished French analyst, born in 1759 at Mutzig in Alsace. He was professor of mathematics at Straasbourg, and author of the *Traité du Calcul des Dérivations*, a work of great merit. This amiable man died on the 8th April 1803.

ARGOL, or ARGAL, the commercial name for crude tartar, which encrusts the sides of vessels in which wine has been kept. It is much used in dyeing to dispose the stuffs to take their colours the better.

ARGONAUTS, the name given to Jason and his companions who, to the number of fifty, embarked in the ship Argo. "The designs of the Argonauts," says Dr Gillies, in his *History of Greece*, "are veiled under the allegorical, or at least doubtful phrase of *carrying off the golden fleece;* which, though easily explained, if we admit the report that the inhabitants of the eastern banks of the Euxine extended fleeces of wool in order to collect the golden particles which were carried down by the torrents from Mount Caucasus, is yet described in such various language by ancient writers, that almost every modern who examines the subject thinks himself entitled to offer, by way of explanation, some new conjecture of his own. But in opposition to the most approved of these conjectures, we may venture to affirm that the voyage to Colchis was not undertaken with a view to establish extensive plans of commerce, or to search for mines of gold, far less to learn the imaginary art of converting other substances into that precious metal; all such motives supposing a degree of speculation and refinement unknown in that age to the gallant but uninstructed youth of Thessaly. The real object of the expedition may be discovered by its consequences. The Argonauts fought, conquered, and plundered; they settled a colony on the shores of the Euxine, and carried into Greece a daughter of the king of Colchis, the celebrated Medea, whose crimes and enchantments are con-

demned to eternal infamy in the immortal lines of Euripides."

ARGONAUTS *of St Nicholas* was the name of a military order instituted by Charles III., king of Naples, in the year 1382, for the advancement of navigation, or, as some say, merely for preserving amity among the nobles. They wore a collar of shells inclosed in a silver crescent, from which hung a ship with this device, *Non credo tempori*, I do not trust time. Hence these Argonaut knights came to be called *knights of the shell.* They received the order of St Basil, archbishop of Naples, and held their assemblies in the church of St Nicholas their patron.

ARGONNE, the old name of a district in France, now included in the departments of Marne, Meuse, and Ardennes. It may be described as a vast forest interspersed with a few towns and villages, and hence called the Forest of Argonne.

ARGOS, an ancient name of Peloponnesus, from Argos, one of the kings. Strabo derives the name from a Thessalian word signifying a plain.

Several ancient cities bore the name of Argos, particularly the capital of Argolis or ARGEIA. Argos was originally the seat of nine petty sovereigns of the family of the Inachides, the last of whom was expelled by Danaüs, whose descendants were termed Belides. Agamemnon was king of Argos during the Trojan war: but 80 years afterwards, his descendants were deposed by the Heraclidæ; and Argos assumed a republican form of government, which it retained until the dissolution of the Achæan league. The character of this state contrasts unfavourably with some other of the Grecian republics. It tyrannized over Mycenæ, which it destroyed 568 years B.C.: it did not join the Greek confederacy against Persia, and was constantly opposed to Sparta. The great deity of the city was Hera, or Juno, who had a grand temple there, existing in the time of Pausanias.

Argos was founded by Pelasgians; and remains of the ancient architecture, commonly called Cyclopean, in a fine state of preservation, may still be seen in its acropolis, on the hill of Larissa, and its spur Deiras. The summit of these eminences is crowned by the ruins of a castle, of the times of the Lower Empire, but it has antique substructions. The only other remains of antiquity at modern Argos are inscriptions, fragments of sculpture, and architecture, scattered in the plain, and among the present houses. Argos, as it was, is described in *Pausanias;* as it is, in Col. Leake's *Travels*, vol. ii.; and Dodwell's *Pelasgic Remains.*

The modern Argos is 5 miles north-west of Napoli di Romania, in Lat. 37. 40. N. Long. 22. 44. E. It contains about 8000 inhabitants.

ARGOS, surnamed *Amphilochicum* to distinguish it from the preceding, was the capital of the territory of the Amphilochians. It stood at the eastern extremity of the Ambracian Gulf. When Augustus, after the battle of Actium, founded Nicopolis, he removed the inhabitants of Argos to that city. The modern village of *Neokhori* is supposed by Col. Leake to occupy the site of this city.

ARGOSTOLI, a seaport town, capital of Cephalonia, one of the Ionian islands. The town has lately been much improved, and has a quay a mile in length, and a fine bridge. Pop. 5000. Lat. 38. 10. 40. N. Long. 19. 59. 3. E.

ARGUIN, a small island in a bay of the same name, situated on the western coast of Africa, near the southern termination of the Great Desert. Major Rennell supposes it to be the island to which the ancients, and particularly Hanno, gave the name of Cerne. The Portuguese early formed a settlement there, and even made it for some time the principal point from which they attempted to penetrate into the interior; but the extensive deserts by which it was bordered were very unfavourable for this object, and the banks of the Senegal have been found more advantageous in every respect. The shores round Arguin, however, abound with valuable turtle, and the sea affords a considerable supply of stock fish. Long. 16. 20. W. Lat. 20. 23. N.

ARGUMENTUM AD HOMINEM, is that form of argument which presses a person with the consequences drawn from his own principles, concessions, or conduct.

ARGUN, ARGAN, or ERGON, a river of Tartary, in the country of the Mongols, which rises from a lake called Dalai, or Koulon-nor, situated in Long. 119. 14. E. and Lat. 49. N. It is considered to be the original source of the Amur, and forms the boundary between the Chinese and Russian empires.

ARGUNSKOI, a town and fortress of Siberia, in the government of Irkutsk, on the west bank of the river Argun, 162 miles from its mouth.

ARGUS, in *Fabulous History*, was the son of Arestor, and had 100 eyes, 50 of which were always open. Hera made choice of him to guard Io, whom Zeus had transformed into a white heifer; but Zeus, pitying Io for being so closely confined, sent Hermes, who with his flute charmed Argus to sleep, sealed up his eyes with his caduceus, and then cut off his head. Hera, to reward his fidelity, transplanted his eyes into the tail of the peacock, a bird which was sacred to her divinity.

ARGUS-SHELL, a species of porcelain shell, beautifully variegated with spots, resembling in some measure those in a peacock's tail.

ARGUTIÆ, witty and acute sayings, which commonly signify something further than the mere words at first sight seem to import.

ARGYLESHIRE, or ARGYLLSHIRE, a county on the western coast of Scotland, comprehending not only an extensive district on the mainland, but also a number of the Hebrides or Western Isles.

The mainland lies between Lat. 55. 15. and 56. 55. N., and between Long. 4. 32. and 6. 6. W.; and its greatest length from the Mull of Cantire to Lochiel is 115 miles, with a breadth of about 66 miles. It is bounded on the north by Inverness-shire, east by the counties of Perth and Dumbarton and the Firth of Clyde, south by the Irish Sea, and on the west by the Atlantic Ocean. From the windings of the numerous bays and creeks with which the land is everywhere indented, it is supposed to have more than 600 miles of sea-coast. This part of the county contains 2260 square miles, or 1,446,400 acres.

The islands of Argyleshire belong to the HEBRIDES; and a more particular account of them will be found in that article. See also ISLAY, MULL, JURA, &c. The islands have a superficial area of 950 square miles, or 608,000 acres.

The entire country thus contains 3210 square miles, or 2,054,400 acres, of which only about 165,000 acres are cultivated. It is divided into six districts, viz., Argyle, Cowal, Kintyre, and Knapdale, Lorn, Mull, and Islay; and contains 51 parishes, and parts of two others.

The general features of the county are varied, and striking in a high degree, consisting of lofty mountains, deep glens, and inlets of the sea entering far into the land. Towards the northern parts it assumes the wild and savage grandeur so peculiarly characteristic of the Highlands of Scotland. Mountains piled on mountains in magnificent disorder present a sublime, but, in an agricultural point of view, a very unpromising aspect. Some of the mountains are among the loftiest is Scotland; as Ben Cruachan, near Loch Awe (3669 feet), Benmore, in Mull (3168), Cruach-Lussa (3000). The inlets of the sea are very numerous; the principal of which are Loch Fyne, Loch Linnhe, Loch Etive, Loch Sunart, Loch Leven, &c. The district of Kintyre enters into the North Channel, and is almost divided from the mainland at the narrow isthmus of Tarbet. The district of Cowal is also nearly peninsulated by Loch Long on the one side, and Loch Fyne on the other. The interior of the county is in-

terspersed with a number of lakes, the principal of which is Loch Awe.—(See AWE.) The total area of fresh-water lakes in Argyleshire is about 52,000 acres. The rivers, as might be expected from the nature of the country, are all short and rapid.

The mainland is chiefly composed of primary strata, consisting of gneiss, mica-slate, often containing chlorite and talc-slate, quartz rock, and in some places clay-slate, and red sandstone. The districts of Kintyre, Knapdale, Cowal, Glenorchy, and the eastern part of Lorn, present the five first-mentioned, almost everywhere, until they meet the granite on the northern side of Loch Etive, and the trap formations of Western Lorn. These primary strata reappear in Appin, and then they give place to clay-slate, which is extensively quarried at Balachulish. Those primary rocks also form a part of Sunart and Morven. Gneiss and mica-slate are the general rocks on both sides of Loch Fyne; and at the ferry of St Catherine, opposite to Inverary, is the quarry of chlorite-slate of which the ducal castle is built.

Gneiss, mica-slate. and quartz-rock, are the principal strata of the isles of Coll and Tirey, Colonsay, Oransay, and of Iona; they are found also alternating with the clay-slate which constitutes the greatest part of Islay, Scarba, and Jura. The remarkable summits known as the *paps* of Jura, consist of very regularly stratified quartz-rock, which, indeed, is the fundamental rock of that island.

Granite, except in veins, is rather rare in Argyle. A considerable extent of this rock exists to the north and north-east of Loch Etive; and at the south-west of Mull, the extreme end of the promontory of Ross, is a granitic mass that seems to extend to the adjacent island of Iona. This granite is hard and compact, well suited for building, and has been quarried for the magnificent lighthouse erected on the Skerry Vohr. Gneiss, mica-slate, and quartz-rock, rest on the eastern side of the granite, and are interposed between it and the trap formations of the island.

Clay-slate forms a large portion of some of the islands of this county. A very durable and fissile species of this rock has long been quarried in some of what have been locally denominated the *Slate Islands*. The western side of Lunga consists of quartz-rock; but on its eastern side is found a fine roofing slate, similar in quality to that long wrought in the small isle called Easdale, with which a great many houses in Scotland are covered. These slates always contain bright, hard crystals of iron pyrites. Luing, Seil, and Torosa, also afford roofing slate, and a coarser sort that forms a good paving flag, which seems associated with greywacke.

Trap rocks form no inconsiderable part of this county. They occupy a wide district on the west side of Lorn, from Milford Loch, stretching northward beyond the entrance of Loch Etive, as far as Loch Creran. There they generally appear as greenstone and trap-tuffa. They constitute about nine-tenths of Mull. The western part of Ardnamurchan and Morven, on the north side of Mull Sound, are also of trap formations; as are the islands of Kerrera, Ulva, Gometra, the Treshnish group, and the beautiful columnar cliffs and caves of Staffa. To the same formation we must refer the more distant isles of Canna, Muck, and Eig; but on the two former there seem to exist small vestiges of a lias limestone, to which those green isles are probably indebted for their fertility. Eig, if it be allowed to notice it here, consists of a huge bed of trap, through which the singular porphyritic mass of the *Scur* abruptly projects to the height of 470 feet. In the trap-tuffa of Canna, fragments of lignite or brown coal are found. The rocks of the more considerable island of Rum are strata of quartz rock and red sandstone, traversed by numerous veins of basalt, in which most beautiful masses of heliotrope occasionally occur. The trap in many places also affords beautiful specimens of stilbite, mezotype, and other zeolites. They all affect more or less the magnetic needle, especially that of the *Compasshill* in Canna. In the trap-tuffa at Ardtunhead in Mull, the Duke of Argyle, in 1850, discovered, alternating with basalt beds, three beds containing petrified leaves of plants. This tuffa resembles much the *lava ashes* of Auvergne.

Limestone is not an abundant product of Argyle. Considerable strata of a bluish limestone, however, alternate with clay-slate in the central parts of Islay; and this valuable stone forms the upper stratum of the long island of Lismore. A white hard dolomite occurs as a bed in the primitive strata on the south side of Iona. It takes a good polish, and is variegated with specks of noble serpentine and indurated stealite. In Tirey, a flesh-coloured marble, spotted with dark green hornblende, occurs in small quantity in gneiss. Argyle is poor in metals. The only lead-mines now wrought are at Strontian in Sunart. In these mines were discovered in the last century the rare minerals strontianite and cross-stone. In 1849 the Duke of Argyle discovered near Inverary, a vein of arsenical nickel in mica-slate, which is now worked with favourable prospects.

A barrenness of soil and scanty vegetation prevail chiefly on the higher parts of the mountains, which exhibit great masses of stratified rocks or groups in a columnar form. Some of the glens are covered with large fragments of these, which have been precipitated from the impending cliffs, and consequently they afford scanty pasturage; the greater part of them, however, yield good grass. Others of them exhibit fertility, verdure, and cultivation, for miles, particularly Glendarual, the most prolific valley of the county. Formerly Argyleshire was interspersed with numerous woods, which, uniting with the lofty mountains, formed the most romantic scenery. But these have been almost all cut down or destroyed to make way for the introduction of sheep; and planting has not, except in a few instances, been carried to any considerable extent. Archibald Duke of Argyle and his son planted very extensively in the neighbourhood of Inverary, and several other proprietors have followed their example; nevertheless, one of the most striking features in the aspect of the county is its want of wood. Remains of ancient forests are still very extensive in various places; and these consist chiefly of oaks, ashes, pines, and birches.

The fallow-deer, which formerly abounded in the woods and on the mountains, are now to be seen only in the preserves of a few gentlemen; but red deer are still found in considerable numbers in Glen Etive and in Mull. Roes are pretty numerous in the northern parts of the county, and both species of moor-game are also found in abundance. The black cattle, which in former times ran wild on the mountains, are now entirely confined to the low grounds, where their young are fed in winter by the proprietors. Fish are not at all so abundant as is generally supposed; for although white fish are taken in considerable numbers, particularly in the neighbourhood of Campbeltown, still the quantity is small compared with what is taken on other parts of the Scottish coast; and Loch Fyne is the only inlet of the sea distinguished for its herring-fishery. In 1851 the herring fishery at Inverary produced 35,325 barrels of cured fish, and 4500 barrels of fish sold uncured; while the white fishery (cod, ling, &c.), 255,882 fish; of which, 8658 cwt. were dried, and 5000 cwt. were sold fresh. The number of boats employed that year was 1445, manned by 4689 men, and the fishings gave employment to 6432 persons. (*Report of Fishery Board*, 1851.)

From its situation on the coast, the temperature of Argyleshire is mild, but very moist and variable. The only crops cultivated to any extent are bere or big, oats, and potatoes. The last form the staple food of the people, and they have consequently suffered severely from the recent failures of that crop. Bere is cultivated to supply the numerous distilleries, which afford employment

to a considerable portion of the inhabitants. The chief branch of industry is the rearing of cattle and sheep. The cattle, though of small size, are equal, if not superior, to any other breed in the kingdom, and are in great demand in the markets of the south, to which they are sent in immense numbers. Dairy husbandry is practised to some extent in the southern parts of Kintyre, where there is a large proportion of arable land. In the more elevated tracts, sheep have very advantageously been substituted for cattle. Until the middle of last century, the only sheep in Argyleshire were of the small native race, and their number was inconsiderable; but these have entirely disappeared, and are now to be found only in the most distant islands of the Hebrides. The blackfaced is the species that is now almost universally reared. About the period above referred to, coarse-woolled heath sheep were introduced into the higher and more barren districts; and as it was soon discovered that the scanty herbage of these gloomy mountains could be converted into a much greater quantity of mutton than of beef, besides yielding a valuable article of manufacture, these hardy animals soon spread over extensive regions, upon which cattle could barely subsist in the summer months; and the income of the landed proprietors was augmented in proportion.

The commerce of Argyleshire is very limited, its exports consisting chiefly of raw produce: sheep, cattle, and fish, form at least two-thirds of the whole; and slates, oak bark, and kelp, constitute nearly the remainder. The imports are almost confined to the supply of necessaries, principally oatmeal and flour, and such articles of luxury as habit has rendered scarcely less indispensable.

Notwithstanding its natural advantages, this county is far from being characterized either by wealth or industry: its manufactures are trifling. It was expected that the Crinan Canal, which was cut across the peninsula of Kintyre at an expense of L.140,000, shortening the voyage from the West Highland and Hebridean ports to the River Clyde nearly 200 miles, would cause an influx of wealth to the county; but neither this nor the Caledonian Canal, which gives access from the county to the German Ocean, has answered the expectations of the projectors, or contributed in any great degree to the prosperity of Argyleshire. The introduction of steam navigation has, however, recently given a great impulse to agriculture and industry. There is not now a loch, bay, or inlet of the county, but is in daily, or at least weekly, communication with Glasgow; and cheerful villas and watering-places are rapidly rising on the shores within a convenient distance of the western capital.

This county still contains many ancient monuments, which display the warlike spirit of its former inhabitants. In the course of the eighth and ninth centuries it was conquered, along with the neighbouring isles, by the Danes and Norwegians. For five or six centuries it continued under the dominion of Norway, and during that period was under the direct administration of feudal chieftains, generally of Norwegian extraction, who each maintained an almost independent government. Along with the Hebridean Isles, all the western parts of Argyle became the conquest of the Scottish monarchs in the fourteenth century. Some time after, Macdonald, the representative of this region, obtained leave from the Scottish crown to hold his possessions as a feudatory to that kingdom; but his turbulent spirit involved him and his family in repeated rebellions, which were at last punished by the forfeiture of their estates, which, along with their titles, were bestowed on the Campbells; and these have ever since retained them in peace and loyalty. The county of Argyle gives the title of *Duke* and *Earl* to the chief of this family, who likewise holds several important offices under the crown. The chief of Argyle in former times could on occasion bring 3000 or 4000 fighting-men into the field. This clan is numerous in Argyleshire, and there are a great number of castles and seats belonging to gentlemen who hold of the duke, and not a few of whom claim alliance with his family.

The county returns one member to parliament, and forms a synod with six presbyteries. Inverary, Campbelton, and Oban, are contributory burghs to Ayr. It is governed by a heritable lord-lieutenant (Duke of Argyle), a lord-lieutenant and high-sheriff, about 55 deputy-lieutenants, a sheriff, and four substitutes. Sheriff-courts are held at Inverary, Tobermory, Campbelton, and Fort-William; and circuit-courts, four times a year, at Oban, Lochgilphead, Dunoon, and Bowmore in Islay.

The population of Argyle has been decreasing since 1831, from the extensive emigration that has been going on, principally to Canada. The following is the state of its population since the commencement of the present century, viz., in 1801, 81,277; 1811, 86,541; 1821, 97,316; 1831, 100,973; 1841, 97,371; 1851, 88,567.

ARGYRASPIDES (ἀργυράσπιδες), a name given by Alexander the Great to a division of his army which had bucklers covered with silver. In this he was imitated by Alexander Severus, who had bodies of men called *Argyroaspides* and *Chrysoaspides*.

ARGYRO-CASTRO, a town in Albania, in Lat. 40. 7. N. Long. 20. 13. E. Here the late Ali Pasha built a strong castle capable of lodging 5000 men. The town is estimated by Holland and Hobhouse to contain 20,000 inhabitants. Till 1811, it enjoyed a sort of rude independence. It is now in possession of the Turks.

ARGYROPULUS, JOANNES, a native of Constantinople, was one of the principal revivers of Greek learning in the fifteenth century. He removed to Italy in 1434, where he obtained the patronage of Cosmo de' Médicis, whose son Pietro, and grandson Lorenzo, he instructed in Greek. In 1480 he removed from Florence to Rome, where he was appointed to a philosophical chair, and died in 1486. His principal works consist of Latin translations of Aristotle. He was singularly prejudiced against the Latin authors, and against Cicero in particular, to whom he denied any knowledge of Greek or philosophy.

ARIADNÆA, festivals solemnized at Naxos and Cyprus in honour of Ariadné. Some Naxian writers recognized two distinct persons of this name; one who was married to Bacchus in Naxos and deified after death, the other deserted by Theseus. The festivals of each, accordingly, were attended with rites of a very opposite nature; those of the first being celebrated with music and other expressions of mirth, whereas the latter were observed with a show of mourning. This festival is said to have been instituted by Theseus, to atone for his ingratitude to Ariadne.—*Plutarch. in Thes.*

ARIADNE was the daughter of Minos king of Crete, and Pasiphaë. Falling deeply in love with Theseus when he arrived in Crete to deliver the young Athenians from the Minotaur, she gave him a clue of thread by which he was enabled to escape from the intricate mazes of the labyrinth. Theseus slew the monster, and carried off Ariadne and her young companions; but on landing at Naxos he treacherously abandoned her, though pregnant, and pursued his course. Ariadne, overwhelmed with grief, destroyed herself. According to another tradition, the god Bacchus found her in Naxos, and filled with amazement at her surpassing beauty, made her his wife; and at her death he placed her bridal crown among the stars.

Several versions of this popular story are given in the *Theseus* of Plutarch. It was a favourite theme with the poets of antiquity, and furnished the subject of many exquisite works of ancient art; as also in later times it has employed the pencil of Titian and other eminent masters.

ARIANO, a city of the Principato-Ultra, in Naples, with several churches and convents, a cathedral, and a mountain-fortress. It stands on a steep hill in a pass of the Apennines. It has manufactures of earthenware, and considerable trade in wine and butter. Pop. 12,000.

ARIANS, followers of Arius, a presbyter of the church of Alexandria about the year 315, who maintained that the Son of God was totally and essentially distinct from the Father; that he was the first and noblest of those beings whom God had created, the instrument by whose subordinate operation he formed the universe, and therefore inferior to the Father both in nature and dignity; also, that the Holy Ghost was not God, but created by the power of the Son. The Arians owned that the Son was the *Word*, but denied that the *Word* was eternal. They held that Christ had nothing of man in him but the flesh, to which the Λόγος or Word was joined, which was the same as the soul in us. See Arius.

The appellation of *Arian* has been indiscriminately applied in more modern times to all those who consider Jesus Christ as inferior and subordinate to the Father, and whose sentiments cannot be supposed to coincide exactly with those of the ancient Arians. Mr Whiston was one of the first divines who revived this controversy in the beginning of the eighteenth century. He was followed by Dr Clarke, who published his famous book entitled *The Scripture Doctrine of the Trinity*, in consequence of which he was reproached with the title of *Semi-Arian*. Dr Waterland, who has been charged with verging towards Tritheism, was one of his principal adversaries. The history of this controversy may be found in a work entitled *An Account of all the considerable Books and Pamphlets that have been wrote on either side, in the Controversy concerning the Trinity, from the Year* 1712*; in which also is contained an Account of the Pamphlets written this last year on each side by the Dissenters, to the end of the year* 1719; published in London in 1720.

ARIAS Montanus, a learned Spanish divine, sent to Antwerp by Philip II. of Spain to publish another edition of the polyglott Bible after that of Cardinal Ximenes. After finishing the work with approbation, he returned to Seville, where he died in 1598.

ARICA, a district and town in Peru. It stands on the coast in the vicinity of a vast sandy desert extending to the foot of the Western Andes. The town is in a narrow valley, watered by a small stream, to which it owes its fertility. This valley is 18 miles in length. Arica is one of the few seaports on this part of the coast of South America. Its chief exports are wool, copper, and silver.

ARICINA, in *Mythology*, a surname of Diana, under which appellation she was honoured in the forest Aricine, so called from Aricia, a town of Latium, at the foot of the Alban Mount. Her temple stood on the margin of the lake of Nemi.

ARIEGE, a southern department of France, formed out of the ancient county of Foix, and parts of Gascony and Languedoc. It is bounded on the scuth by the Pyrenees, on the east by the departments of Pyrenees Orientale and Aube, and north and west by that of Haute Garonne. Its subdivisions, with their population, are as under:—

Arrondissements.	Cantons.	Communes.	Population in 1851.
Foix	8	141	92,671
Pamiers	6	114	82,197
St Girons	6	81	92,567
3	20	336	267,435

From east to west its extent is 66 miles; from north to south 49 miles; and its area 1756 square miles.

The departments of Foix and St Girons are mountainous, and contain some of the loftiest peaks in France; as Pic d'Estats, which is 10,811 feet; Montcalm, 10,512 feet; Serre, 9592 feet; Monteleon, 9424 feet; Montvalier, 9120 feet. This mountainous district contains many small valleys, and two principal ones, which are watered by the Ariège and Salat, considerable affluents of the Garonne, and are very fertile and sedulously cultivated. The produce of the lowlands is grain, sweet chesnuts, apples, and peaches; but the vines produce an inferior wine, which is wholly retained for home consumption. The uplands afford abundant pasturage for cattle, horses, mules, and sheep; and the mountain slopes produce fine timber, oak, beech, ash, and pine. The departments of Foix and St Girons yield some copper, and the most valuable iron mines of France, with a considerable quantity of lead, from which silver is extracted; and the streams afford some grain-gold. The principal iron mines are those of Ax, Taracon, and Vic-Dessus. Around the latter are numerous smelting works, which have been actively carried on for ages; and the vicinity is studded with the neat houses of the iron-masters and their numerous workmen, mingled with the remains of feudal strongholds that once were of importance on this frontier of Spain. (T. S. T.)

ARIENZO, a city of Naples, in the province of Lavoro. It stands on a hill, with an ancient castle overlooking it: and contains seven parish churches, a hospital, and 11,000 inhabitants, including the populous suburbs.

ARIES, in *Astronomy*, a constellation of fixed stars drawn on the globe in the figure of a ram. It is the first of the twelve signs of the zodiac, from which a twelfth part of the ecliptic takes its denomination.

Aries. See Battering-Ram.

ARIMANES, the evil god of the ancient Persians. According to the doctrine of the magi, there are two supreme principles—a good and an evil; the first the author of all good, and the other of all evil: the former represented by light, and the latter by darkness, as their truest symbols. The good principle they named *Yezad* or *Yesdan*, and *Ormuzd* or *Hormizda*, which the Greeks wrote *Oromasdes;* and the evil demon they called *Ahriman*, and the Greeks *Arimanes*. Some of the magians held both these principles to have existed from all eternity; but this sect was reputed heterodox, the original doctrine being that the good principle only was eternal, and the other created.

ARIMASPI (Ἀριμασποί), a Scythian people described by Herodotus as *Cyclopes*, living in the gold districts of the Ural Mountains.—Lib. 4, 13, and 27.

ARIOLI, in *Antiquity*, a kind of prophets or religious conjurers, who, by abominable prayers and horrible sacrifices at the altars of idols, procured answers to their questions concerning future events. Isid. *Orig.* lib. viii. cap. 9. These are also called *harioli*, and their operation *hariolatio*. Sometimes they were denominated *aruspices* or *haruspices*. The *arioli* were distinguished by a slovenly dress, disorderly and matted beards, hair, &c.

ARION, a celebrated Lesbian lyric poet and musician, the son of Cyclos of Methymna. After gaining great reputation in Greece, he passed over into Italy and Sicily, where he obtained the public prizes for poetry and music, and amassed considerable wealth during his sojourn in the Græco-Italian and Sicilian states. At length he embarked in a vessel for his native country; but, on the voyage, the crew, to obtain possession of his wealth, conspired to destroy him. The only favour granted to the poet, when he begged for his life, was permission to throw himself into the sea, after performing one of his lyric compositions on the deck of the vessel. A dolphin, it is said, attracted by the music, gambolled around the ship, and receiving the poet on its back, bore him in safety to the shore near Tænarus, whence Arion hastened to the residence of his friend Periander, tyrant of

Arion || Ariosto.

Corinth, a patron of poetry and the fine arts. Arion was well received by Periander, who gave orders to watch the arrival of the ship in which he had embarked. The crew, when questioned where they had last seen Arion, affirmed that they left him well at Tarentum; but Arion appearing suddenly in the garb he had worn before he leapt into the sea, they confessed their villany, and were condemned to crucifixion. The cautious Herodotus, without vouching for its truth, states this to be the tradition of the Lesbians and Corinthians; and adds, that the votive offering of Arion, a bronze figure of a man riding on a dolphin, is to be seen at Tænarus.—*Clio*, 23, 24.

Arion, a fabulous horse, much more famous in poetic history than Bucephalus in that of Alexander. Authors speak variously of his origin, though they agree in giving him a divine one. His production is most commonly ascribed to Neptune.—See Pausan. viii. 25; Apollod. iii. 6.

ARIOSTO, Lodovico, one of the greatest poets of Italy, was born at Reggio in Lombardy, on the 8th of September 1474. His father was Niccolò Ariosto, commander of the citadel of Reggio, and his mother Daria Malaguzzi of that city, where the family still exists. He showed a strong inclination to poetry from his earliest years, but was obliged by his father to study the law—a pursuit in which he lost five of the best years of his life. Having obtained liberty to follow his inclination, he applied himself to literature; intending to study the classics under Gregorio da Spoleti. But after having had the benefit of this learned man's instructions for a short time, during which he read the best Latin authors, he was deprived of it by Gregorio's removal to France as tutor of Prince Sforza. Ariosto thus lost the opportunity of learning Greek, as he intended. His father dying soon after, he was compelled to forego his literary occupations to undertake the management of the family, whose affairs were embarrassed, and to provide for the subsistence and education of his nine brothers and sisters, one of whom was a cripple. He wrote, however, about this time some comedies in prose, and some lyrical pieces. Some of these attracted the notice of the cardinal Ippolito of Este, who took the young poet under his patronage, and appointed him one of the gentlemen of his household. This prince usurped the character of a patron of literature, whilst the only reward which the poet received for having dedicated to him the *Orlando Furioso*, was the question, Where did you find so many stories, Master Ludovic? The poet himself tells us that the cardinal was ungrateful; deplores the time which he spent under his yoke; and adds, that if he received some miserable pension, it was not to reward him for his poetry, which that prelate despised, but to make some just compensation for the poet's running like a messenger, with risk of life, at his eminence's pleasure. Nor was even this miserable pittance regularly paid during the period that the poet enjoyed it. The cardinal went to Hungary in 1518, and wished Ariosto to accompany him. The poet excused himself, pleading ill health, his love of study, the care of his private affairs, and the age of his mother, whom it would have been disgraceful to leave. His excuses were not received, and even an interview was denied him. Ariosto then boldly said, that if his eminence thought to have bought a slave by assigning him the scanty pension of seventy-five crowns a year, he was mistaken, and that he might withdraw his boon —which it seems his eminence did.

The cardinal's brother, Alfonso, Duke of Ferrara, now took the poet under his patronage. This was but an act of simple justice, Ariosto having already distinguished himself as a diplomatist, chiefly on the occasion of two visits to Rome as ambassador to Pope Giulio II. The fatigue of one of these hurried journeys brought on a complaint from which he never recovered; and on his second mission he was nearly killed by orders of that violent pope, who happened at the time to be much incensed against the Duke of Ferrara. On account of the war, his salary of only 84 crowns a year was suspended, and withdrawn altogether after the peace; in consequence of which Ariosto asked the duke either to provide for him, or to allow him to go to seek employment elsewhere. A province belonging to that sovereign, situated on the wildest heights of the Apennines, being then without a governor, Ariosto was sent thither in that character, and remained there for three years. This office was no sinecure. The province was distracted by factions and banditti, the governor had not the requisite means to enforce his authority, and the duke did little to support his minister. Yet it is said that Ariosto's government satisfied both his sovereign and the people confided to his care; and a story is added of his having fallen in, when walking out alone, with a party of banditti, whose chief on discovering that his captive was the poet of *Orlando Furioso*, humbly apologized for not having immediately shown him the respect which was due to his rank.

Although he had little reason to be satisfied with his office, he refused an embassy to Pope Clement VII. offered to him by the secretary of the duke; and spent the remainder of his life at Ferrara, writing comedies, superintending their performance, as well as the construction of a theatre, and correcting his *Orlando Furioso*, of which the complete edition was published only in 1532. He died of a consumption on the 6th of June 1533.

That Ariosto was honoured and respected by the first men of his age is a fact; that most of the princes of Italy showed him great partiality is equally true; but it is not less so that their patronage was limited to kind words. It is not known that he ever received any substantial mark of their love for literature: he lived and died poor. He proudly wrote on the entrance of a house built by himself,

> Parva, sed apta mihi, sed nulli obnoxia, sed non
> Sordida, parta meo sed tamen ære domus;

which serves to show the incorrectness of the assertion of flatterers, followed by Tiraboschi, that the Duke of Ferrara built that house for him. The only one who seems to have given anything to Ariosto as a reward for his poetical talent is the Marquess del Vasto, who assigned him an annuity of one hundred crowns on the revenues of Casteleone in Lombardy; but it was only paid, if ever, from the end of 1531. That he was crowned as poet by Charles V. seems untrue, although a diploma may have been issued to that effect by the Emperor.

The character of Ariosto seems to have been fully and justly delineated by Gabrielle, his brother:—

> Ornabat pietas et grata modestia Vatem,
> Sancta fides, dictique memor, munitaque recto
> Justitia, et nullo patientia victa labore,
> Et constans virtus animi, et clementia mitis,
> Ambitione procul pulsâ, fastûsque tumore.

His satires, in which we see him before us such as he was, show that there was no flattery in this portrait. In these compositions (the interest of which is only equalled by the elegance as well as *naïveté* of the poetry, and the shrewd observation of human nature, we are struck with the noble independence of the poet. He loved liberty with a most jealous fondness. His disposition was changeable withal, as he himself very frankly confesses in his Latin verses, as well as in the satires.

> Hoc olim ingenio vitales hausimus auras
> Multa cito ut placeant, displicitura brevi.
> Non in amore modo mens hæc, sed in omnibus impar
> Ipsa sibi longa non retinenda mora.

Hence he never would bind himself either by going into orders or marrying, till towards the end of his life, when he espoused Alessandra, widow of Tito Strozzi. He had no issue by his wife, but he left two natural sons by different mothers.

His Latin poems do not perhaps deserve to be noticed: in the age of Flaminio, Vida, Fracastoro, and Sannazzaro, better things were due from a poet like Ariosto. His lyrical compositions show the poet, although they do not seem worthy of his powers. His comedies, of which he wrote four, besides one which he left unfinished, are avowedly imitated from Plautus and Terence; and although natives may admire in them the elegance of the diction, the liveliness of the dialogue, and the novelty of some scenes, few will feel interest either in the subject or in the characters, and none will approve the immoral passages with which they are disfigured—a fault, however, less reproachful to the poet than to the audience and patrons of theatrical representations in those days.

Of all the works of Ariosto, the most solid monument of his fame is the *Orlando Furioso*, the extraordinary merits of which have cast into oblivion the numberless romance poems which inundated Italy during the 15th, 16th, and 17th centuries.

The popularity which a poem, now shamefully neglected, the *Orlando Innamorato*, by Boiardo, enjoyed in Ariosto's time, cannot be well conceived, now that the enthusiasm of the Crusades, and the interest which was attached to a war against the Moslems, have passed away. Boiardo wrote and read his poem at the court of Ferrara, but died before he was able to finish it. Many poets undertook the difficult task of completing that magnificent work; but it was reserved for Ariosto both to finish and to surpass his original. Boiardo did not perhaps yield to Ariosto either in vigour or in richness of imagination, but he lived in a less refined age, and died before he was able to put a finishing hand to that part of the poem which he had written under the impulse of his exuberant fancy; while Ariosto, on the other hand, united to a powerful imagination an elegant and cultivated taste. He began to write his poem about 1503, and after having consulted the first men of the age of Leo. X., he published it in 1516, in only 40 cantos; and up to the moment of his death never ceased to correct and improve both the subject and the style. It is in this latter quality that he excels, and for which Italians gave him the name of *Divino Lodovico*. Even when he jests, he never compromises his dignity; and in pathetic description or narrative, he searches the reader's deepest feelings. In his machinery he displays a vivacity of fancy with which no other poet can vie; but he never lets his fancy carry him so far as to omit to employ, with an art peculiar to himself, those simple and natural pencil-strokes with which he gives to the most extraordinary feats a colour of reality which conciliates our reason without undeceiving our bewildered imagination. The death of Zerbino, the complaints of Isabella, the effects of discord among the Saracens, the flight of Astolfo to the moon, the passion which causes Orlando's madness, teem with beauties of every species. The supposition that the poem is not connected throughout is utterly unfounded; there is a connection which, with a little attention, will become evident. The love of Ruggero and Bradamante forms the main subject of the *Furioso;* and every part of it, except some episodes, depends upon this subject. The poem ends with the marriage of these two personages. (A. P—I.)

ARISTÆUS, son of Apollo and Cyrene, who, for the services he had rendered to mankind by his knowledge of all profitable arts, was placed by the gods among the stars.

ARISTANDER, a famous soothsayer under Alexander the Great, over whom he gained a wonderful influence by the good success of his art. He had already had the same employment at the court of King Philip; and it was he who explained better than his brethren the king's dream after his marriage with Olympias. (Plut. *Alex.*)

ARISTARCHUS, a Grecian astronomer of Samos, one of the first who maintained that the earth revolves round the sun. He was the contemporary of Cleanthes, the successor of Zeno. The opinion ascribed to him with respect to the motion of the earth is not to be found in his only existing work, namely his *Treatise on the Magnitudes and Distances of the Sun and Moon.* A Latin translation of the treatise περὶ μεγεθῶν was published by G. Valla, *Venet.* 1498, and another by Commandine, *Pesauri,* 1572. The Greek text, with a Latin translation and the commentary of Pappus, was edited by Wallis, *Oxon.* 1688, and reprinted in vol. iii. of his works. There is also a French translation, with the text, *Paris,* 1810.

ARISTARCHUS of Samothrace, the most famous of Greek grammarians and critics, flourished about 150 years B.C. He received his education at Alexandria under Aristophanes of Byzantium, and was the founder of a school of grammar and criticism that flourished long at Alexandria, and afterwards also at Rome. The young Ptolemy Epiphanes and Physcon were among his pupils. The labours of Aristarchus were directed chiefly to the Greek poets, especially to the works of Homer, his recension of which has been the basis of the text in all subsequent editions down to the present day. In consequence of the ill-treatment experienced by the learned at Alexandria in Physcon's reign, he retired to Cyprus, where he is said to have perished in his 72d year, in attempting to cure himself of a dropsy by excessive abstinence.—See Dr Schmitz in Smith's *Dict. of Greek and Rom. Biogr. and Mythol.*

ARISTIDES, surnamed the *Just*, one of the most illustrious characters of antiquity for purity and integrity, was an Athenian by birth, and contemporary with Themistocles. His father was Lysimachus, a man of middle rank. His character from his youth gave sure promise of that greatness to which he afterwards rose. To a firm, resolute, and placid temper, he added an utter contempt of dissimulation, and an abhorrence of every thing dishonourable. He began very early to meditate on subjects of government, and applied to his studies with the greatest assiduity. He imbibed a strong predilection for oligarchy upon becoming acquainted with the laws of Lycurgus, which excited his admiration, and gave him a distaste for the unlimited democracy then established in his native city. Themistocles, on the other hand, favoured democracy; and it has been said that even at school he was his constant antagonist on that point; but this story is incredible because of the difference of age between the two men. A perpetual opposition to one another in all political points was the consequence of this difference of opinion, when their abilities raised them to several important stations in the state. It is related, that one day having firmly opposed a proposal of Themistocles in the assembly, which in his own conscience he knew to be right, on coming out he exclaimed, "The affairs of the Athenians will never prosper till they throw both of us into the *barathrum*" (the dungeon for condemned criminals).

Aristides was present at the battle of Marathon, B.C. 490, and was next in command among the Athenians to Miltiades; and on that general's proposing to join battle as soon as possible, he seconded his motion with zeal. In the field he distinguished himself by his valour and generosity; and being left after the battle to secure the spoils, he executed his trust with honour and fidelity, bringing all to the public account, reserving nothing for himself. He was elected to the important office of chief magistrate the year following; but, by the art of Themistocles, the high authority he had attained by his merits was at length converted into a means of overthrowing him, and he was accordingly banished by ostracism, B.C. 483. As the Persians were meditating a new invasion of Greece, he employed himself in his exile in encouraging the Greeks to defend their liberties against the invaders. At the critical moment when the hostile fleets were facing each other in the straits of Salamis, Aristides,

though still an exile, suspended all political animosities; and upon understanding that it was the design of Themistocles to fight the Persian navy in the straits, he waited on him in private, proposed an oblivion of all past circumstances, extolled his intentions, and gave him his sincere promise to assist him to the utmost in effecting his designs. There is an anecdote, that Themistocles, some time after the battle of Salamis, acquainted the Athenians that he had formed a scheme which, although it was of such a nature as forbade his public avowal of it to them, was of inestimable advantage to the state. They immediately ordered that he should communicate it to Aristides. It was a project for consuming the whole confederate fleet of Greece by fire, except their own ships; that thus the entire sway of the sea might be left to the Athenian navy. Aristides replied that nothing could be more unjust, and at the same time nothing more advantageous, than the scheme of Themistocles. Upon this the people immediately determined to dismiss any further thought of it. Aristides, who must have returned from exile before the battle of Platæa, was of considerable service in persuading his countrymen, who were elated with their former successes, to submit to the superior power of the Spartans, and in preserving peace and amity between the confederate forces. He acquitted himself with high distinction in the engagement, and was appointed after the victory to determine a very dangerous dispute concerning the honour of the day, which he conferred upon the Platæans, giving up the claim of the Athenians, the Lacedæmonians following his example. On the rebuilding of Athens, he was the first person to promote a law which divided the administration among the citizens at large, and passed a law that the archons should be elected out of the whole body of the people, who had so highly merited the favour of the state.

Upon the continuation of the war with the Persians, Aristides, was sent, along with Cimon the son of Miltiades, to take the command of the Athenian forces in the confederate army. Their mildness and humility, compared with the haughty domineering temper of Pausanias, and other Spartan commanders, so won upon the rest of the allies, that a confederation was formed under the supremacy of Athens, with the joint concurrence of the Ionian states. The nomination of Aristides to lay an equal assessment upon all the states for the purpose of defraying the expense of the war, was a signal proof of the high opinion entertained throughout all Greece of his integrity and justice. The wisdom and impartiality with which he performed this commission gave universal satisfaction. On Themistocles's falling under the displeasure of the ruling party, Aristides would not concur in a capital prosecution of him; and instead of triumphing over an old enemy, he always spoke of him after his banishment with the highest respect.

This great man died about 468 years B.C., according to some at Athens, at an advanced age; others say at Pontus, where he was transacting public business. He was buried at the public expense, his daughters received portions out of the public treasury, and an estate in land was bestowed on his son Lysimachus, in gratitude for the signal services which Aristides had rendered to his country.

ARISTIDES, *P. Ælius*, surnamed Theodorus, a distinguished Greek rhetorician, born at Adriani in Mysia about A.D. 117. After studying at Athens under Herodes Atticus, he travelled through Egypt, Greece, and Italy. Though his health was extremely delicate, he pursued his rhetorical studies with unremitting assiduity, and acquired so great a reputation that statues were erected in his honour by several of the states he visited. His overweening estimation of his own abilities, however, induced some persons to underrate his merits, and exposed him to frequent enmities. He settled at Smyrna; and when that city was ruined by an earthquake A.D. 178, the eloquence of his appeal induced M. Aurelius to assist the citizens in restoring it. In gratitude for this service they would have heaped honours on Aristides, but he declined to receive anything but the office of priest of Asclepius, which he held till his death, about A.D. 189. His *Sermones Sacri* contain several curious passages respecting the cures of the sick in temples, which have excited considerable attention in modern times by their apparent resemblance to certain effects said to be produced by Mesmerism, or, more properly, *Hypnotism* or nervous sleep. Fifty-five of his orations and declamations are extant, and two treatises on rhetoric, of little value. A complete edition of his works was published by W. Dindorf, Lips. 1829, 3 vols. 8vo.

ARISTIDES, *Quintilianus*, the author of a valuable treatise upon music, who probably lived in the first century of our era. The work is printed in the collection of Meibomius, entitled *Antiquæ Musicæ Auctores Septem*, Amst. 1652.

ARISTIDES, a painter contemporary with Apelles, flourished at Thebes about B.C. 360–330. He was the first, according to Pliny, who expressed character and passion, but was not remarkable for softness of colouring.

ARISTIPPUS, the founder of the Cyrenaic sect of philosophy, was the son of Aretades, and born at Cyrene in Libya. He flourished about 380 B.C. The great reputation of Socrates attracted him to Athens, where he attended the discourses of that great teacher, whose practical philosophy he freely modified to suit the easy and sensual bent of his own mind. His free and luxurious life was in accordance with his distinctive doctrine, that Pleasure was the highest good of man. Though possessed of a competent estate, he was the only disciple of Socrates who took money for teaching. Upon leaving Socrates he went to Ægina, where he lived even more luxuriously than before. Socrates made frequent attempts to reclaim him, but in vain. In Ægina Aristippus became acquainted with Laïs, the famous courtezan of Corinth, for whose sake he took a voyage to that city. He continued at Ægina till the death of Socrates. After this he visited the court of Dionysius, tyrant of Sicily, where he spent a considerable time, leading a life of unrestrained enjoyment. On his return to Cyrene to visit his daughter Arete, he fell sick and died at Lipara.

Many of his apophthegms are preserved. To one who asked him, what his son would be the better for being a scholar, "If for nothing else," said he, "yet for this alone, that when he comes into the theatre one stone will not sit upon another." When a certain person recommended his son to him, he demanded 500 drachmas; and upon the father's replying that he could buy a slave for that sum, "Do so," said he, "and then you will be master of a couple." Being reproached because, having a suit of law pending, he fee'd a lawyer to plead for him, "Just so," said he, "when I have a great supper to make I always hire a cook." Being asked what was the difference between a wise man and a fool, he replied, "Send both of them together naked to those who are acquainted with neither of them, and then you will know." Being reproached for receiving money of Dionysius, at the same time that Plato accepted only a book, "The reason is plain," said he, "I want money and Plato wants books."

The doctrine of Aristippus is summed up in the word *Enjoyment*. The final end of man's existence, according to him, is *the Good*. Pleasure and pain are the two poles of his being,—the one is essentially good, the other essentially evil. To follow the one and flee the other is the whole duty of man. Pleasure is essentially present; the hope of future good being always conjoined with fear. Free and immediate abandonment to all the instincts of nature alone leads to true happiness. Herein the doctrine of Aristippus differs from that of Epicurus, who inculcated the necessity of a wise calculation of consequences, and a choice

of pleasures. Aristippus, again, held that all pleasures were equally good, whatever their origin, those of the body, as more immediately realized, being higher in degree.

Of the numerous works of Aristippus, of which a list is given by Diogenes Laertius, none has been preserved. M. Luzac, in his *Lectiones Atticæ*, has shown that he was not the author of the treatise on the *Luxury of the Ancients*, frequently ascribed to him; nor of the *Epistles* given as his in the Socratic collection of Leo Allatius.—See F. Mentzius, *Aristippus, &c.*, 4to, Halle, 1719; Batteux, *Développement, &c.*, in vol. xxvi. of the *Mém. de l'Acad. des Inscript.*; Kunhardt, *Diss. Philos. Histor. de Aristipp. Phil. Mor.* 4to, Helmst, 1796; and Wieland's *Aristippus*, 8vo, Leipsic, 1800–2.

ARISTO of Chios, a Stoic philosopher, the disciple of Zeno, flourished about 290 years before the Christian era. He differed but little from his master Zeno. Rejecting logic as of no use, and natural philosophy as being above the reach of the human understanding, he confined himself exclusively to morals. He founded a sect apart from that of his master, which had but a brief existence. To him is attributed the saying commented on by Epictetus and Antonine, that "the wise man is like a good comedian, equally capable of playing the part of Agamemnon, or of Thersites."—See Cic. *de Leg*, i. 13; *de Fin.* ii. 13; iv. 17; Diog. Laert. vii. 160, &c. Another philosopher of the same name, a Peripatetic, was a native of Ceos, and lived about 260 B.C. Cic. *de Fin.* v. 5; Diog. Laert. v. 70, 74; vii. 164.

ARISTOBULUS of Cassandria, one of the generals of Alexander the Great; wrote a history of his expedition, of which but a few imperfect fragments remain. He was regarded as a writer of high veracity.

ARISTOBULUS, a Jew of Alexandria, who lived about the middle of the second century. He is remarkable as having, along with Philo, set the example of that mode of interpretation which sought to find a harmony between the pagan mythology and the doctrines of the Hebrew Scriptures. He is said to have forged in the works of profane authors numerous passages tending to prove that they had borrowed from the Bible. This pious fraud deceived many of the Christian fathers and of the heathen writers. Aristobulus wrote pure Greek, unmixed with Hebrew idioms.

ARISTOBULUS. See JEWS.

ARISTOCRACY (ἀριστοκρατία, *the rule of the noblest*). See GOVERNMENT.

ARISTOGITON, a famous Athenian, who, with Harmodius, killed Hipparchus, tyrant of Athens, about 513 B.C. The Athenians erected a statue to him. See HARMODIUS.

ARISTOLOCHIEÆ, a natural order of Monochlamydean plants, of which the chief genera are Aristolochia, and Asarum, the medicinal qualities of which are purgative and emetic.

ARISTOPHANES, a celebrated comic poet of Athens. He was contemporary with Plato, Socrates, and Euripides; and most of his plays were written during the Peloponnesian war. His imagination was warm and lively, and his genius particularly turned to raillery. He had also great spirit and resolution, and was a declared enemy to the war party, and to all the numerous reformers in politics and religion. The Athenians suffered themselves in his time to be governed by men who had no other views than to make themselves masters of the commonwealth. Aristophanes exposed the designs of these men with great wit and severity upon the stage. Cleon was the first whom he attacked, in his comedy of the *Knights*, performed in B.C. 425; and as there was not one of the comedians who would venture to personate a man of his great authority, Aristophanes played the character himself, and with so much success, that the Athenians obliged Cleon to pay a fine of five talents, which were given to the poet. He described the affairs of the Athenians in so exact a manner that his comedies may be regarded as a nearly faithful picture of his time. For this reason, when Dionysius king of Syracuse desired to learn the state and language of Athens, Plato sent him the comedies of Aristophanes. He wrote above 50 comedies, but there are only 11 extant which are perfect: these are, *Plutus, the Clouds, the Frogs, the Knights, the Acharnians, the Wasps, Peace, the Birds, the Ecclesiazusæ or Female Orators, the Thesmophoriazusæ or Priestesses of Demeter*, and *Lysistrata*. *The Clouds*, which he wrote in ridicule of Socrates, is the most celebrated of all his comedies. Having conceived some aversion to the poet Euripides, Aristophanes satirizes him in several of his plays, particularly in his *Frogs* and his *Thesmophoriazusæ*. He wrote his *Peace* in the 10th year of the Peloponnesian war, when a treaty of 50 years was concluded between the Athenians and the Lacedæmonians, though it continued but seven years. The *Acharnians* was written with a view to set forth the blessings of peace, and to dissuade the people from intrusting the safety of the commonwealth to such generals as Lamachus. Soon after, B.C. 415, he represented his *Birds*, by which he pictured to the Athenians the deplorable condition of their state and their political situation. The *Wasps* was written after the loss in Sicily, which the Athenians suffered from the misconduct of Chares. He wrote the *Lysistrata* when all Greece was involved in war; in which comedy the women are introduced debating upon the affairs of the commonwealth, when they come to a resolution not to go to bed with their husbands till a peace should be concluded. His *Plutus*, and other comedies of that kind, were written after the magistrates had given orders that no person should be exposed by name upon the stage. He invented a peculiar kind of verse, which was called by his name, and is mentioned by Cicero in his Brutus; and Suidas says that he also was the inventor of the tetrameter and octameter verse.

Aristophanes was greatly admired among the ancients, especially for the true Attic elegance of his style. The time of his death is unknown; but it is certain that he was living after the expulsion of the tyrants by Thrasybulus, whom he mentions in his Plutus and other comedies.

There have been many editions of the works of Aristophanes. The *editio princeps*, printed by Aldus at Venice in 1498, in folio, is a rare and beautiful volume. Among the principal editions are that of Brunck, Strasburg, 1781–3, 4 vols. 8vo, and Oxford, 1810; that of Bekker, London, 1829, 5 vols. 8vo, and that of Dindorf, Oxford, 1835–37, 3 vols. 8vo (vol. 4 Scholia Græca); and Paris, 1838, 1 vol., Lex. 8vo, *Gr. et Lat.* Madame Dacier published at Paris, in 1692, a French version of Plutus and of the Clouds, with critical notes, &c. Theobald likewise translated these two comedies into English, and published them with remarks. Cumberland gave a translation of the Clouds in his *Observer*, accompanied with an able view of the life and genius of the author. A translation of the greater part of Aristophanes, with introductions of considerable length, has been published by Mr Mitchell, 2 vols. 8vo, Lond. 1820–22. Mr Mitchell has also published valuable annotated editions of several of the plays. There are also translations, partial or complete, by Walsh, Wheelwright, an *Oxford Graduate*, and Hickie (Bohn's Class. Lib.)

ARISTOPHANES of Byzantium, the founder of the Alexandrian Critical School, who is said to have invented the system of Greek accents and method of punctuation. He was the master of Aristarchus the grammarian. He flourished in the reign of Ptolemy Epiphanes, about 200 years B.C., and was the author of several exegetical and grammatical works which are lost.

ARISTOTLE.

Aristotle.

The power of philosophy in fixing an impression of itself on the world, appears, when attentively viewed, no less than that evidenced in successful exertions of civil or military talents. But there is a striking difference in the comparative interest excited by the philosopher himself, and by the distinguished statesman or general. The personal fortunes of the philosopher are not connected with the effects of his philosophy. He has passed away from the eyes of men, when his powerful agency begins to be perceived; whereas the statesman and the commander of armies are at once set before us in the very effects which they produce on the world; and the history which tells of their policy or their conquests assumes almost the character of their biographies.

This contrast is strongly displayed in the instance of the particular philosopher whose life we would now retrace. At this day, after the lapse of more than twenty-one centuries from the time when he flourished, we are experiencing the power of Aristotle's philosophy, in its effects on language and literature and science, and even on theology; and yet little satisfactory information can be obtained from antiquity respecting the philosopher himself. No account of him appears to have been given until his celebrity had attracted envy as well as admiration; so that we are compelled to receive with suspicion every thing beyond the simple detail of a few facts.

Stagirus,[1] a Grecian city in the peninsula of Chalcidice, colonized originally from the island of Andros, and afterwards from Chalcis in Eubœa, was the birthplace of Aristotle. His father was Nicomachus, the physician and friend of Amyntas II. king of Macedonia; his mother Phæstis: both of Chalcidian descent. The origin of his family is referred to Machaon, son of Æsculapius. Such a tradition of descent, however, is but an ennobling of the fact that the art of healing was the hereditary profession of the family.[2] The date assigned to his birth is B.C. 384.

Being left an orphan in early youth, Aristotle appears to have quitted his home and gone to the house of Proxenus, a citizen of Atarneus, to whose guardianship he had been committed; and with him to have continued until his seventeenth year, when he repaired to the great University of the world at that time—the school of Plato at Athens. Different accounts are given of the commencement of his application to philosophy. By one it is ascribed to a direction of the Pythian oracle.[3] Others state that philosophy was his last resource, when other schemes of life had failed; that, having exhausted a large patrimony, he became a military adventurer, and after that a seller of drugs; until at length, on accidentally entering the school of Plato, he there received a sudden impulse to the studies of his future life. These last statements, however, are not reconcilable with the period of youth at which his discipleship to Plato began. Nor are they consistent with the alleged fact, that his mind had been from the first trained to philosophy by his father Nicomachus.[4]

We can readily suppose that the extraordinary talent for science, and laborious devotion to it, which his mature age developed, would give some indications of themselves in his earlier years. Hence the expressions attributed to Plato, complimenting him as "the intellect of the school," and "the reader," and comparing his ardour and forwardness to the spirit of a restive colt.[5]

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He remained at Athens, a hearer of Plato, twenty years; leaving it only at the death of that philosopher, B.C. 348, and then going to Atarneus. Disappointment at not succeeding to the chair of Plato in the Academy, has been assigned as the reason of his departure. All that appears, however, is, that he left Athens in compliance with an invitation from Hermias,[6] who, having been his fellow-disciple in the school of Plato, had established himself at that time in independence against the King of Persia, as Tyrant of Atarneus and its neighbourhood. Here he spent the following three years of his life; when the unhappy end of his friend Hermias, who fell a sacrifice to his ambition, and was executed as a rebel against Persia, compelled him to seek a refuge for himself by flight to Mitylene. Nor did he in this extremity forget the ties of friendship which had connected him with the unfortunate Tyrant of Atarneus. To support the fallen family, he married Pythias, the adopted daughter, but variously described both as the sister and as the niece,[7] of Hermias.

From Mitylene he proceeded into Macedonia to the court of Philip, and entered on a new scene of exertion, as the preceptor of the future sovereign of the mightiest kingdom of the ancient world—Alexander the Great, at that time a youth of fourteen years of age. The call to such an office argues the high reputation already attained by Aristotle for philosophy; though, doubtless, his introduction to the Macedonian court must have been through the interest and favour enjoyed there by his father Nicomachus. At what time, indeed, his care of the youthful prince commenced, it is not possible exactly to determine. A letter is extant, addressed by Philip to Aristotle, which would imply that the charge of the prince's education had been committed to the philosopher from the birth of Alexander. This is also far more probable than that the charge should have been postponed until the prince had reached his fourteenth year, the period at which the actual residence of Aristotle at Pella is dated. Philip states in that letter that "a son is born to him; that he is grateful to the gods, but not so much for the birth of the boy, as that he was born in the time of Aristotle; trusting that, being nurtured and trained up by the philosopher, he would be a worthy successor to his father's glory and the conduct of affairs."[8] It is certainly very possible that a plan of education proposed by Aristotle may have been carried on by others, until the more especial care of the intellectual powers demanded his personal instructions. The reception of the philosopher by the royal family was most friendly and honourable to him. The high estimation in which he was held was shewn in the influence he possessed at the Macedonian court. Philip, it is said, gave him liberal supplies of money to enable him to pursue scientific inquiries.[9] He was most happy in the admiration and affection of his pupil. Alexander valued his instructions as those of a second parent; observing, that "he was no less indebted to Aristotle than to his father; since it was

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[1] It is also written Stagira and Stagiri. We have the authority of Herodotus and Thucydides for Stagirus.

[2] Diog. Laert. in *Aristot.*; Dionys. Halicar. *De Demosth. et Aristot.*; Ammon. in *Aristot.*

[3] Ammon. in *Aristot.*

[4] His father Nicomachus has the reputation of being the author of some philosophical works.

[5] Diog. Laert. in *Aristot.*; Ammon. *in Aristot.*; Ælian. *Var. Hist.* iv. 9.

[6] Commonly called Hermias the eunuch.

[7] Aristippus, according to Laertius, says it was the mistress of Hermias that Aristotle married.

[8] Aulus Gellius, *Noct. Att.* ix. 3. The genuineness of the letter has been doubted, but without sufficient reason, if the only ground of objection is, that it could not have been received by Aristotle at Mitylene.

[9] Ælian. *Var. Hist.* iv. 19. The statement of Hermippus (Diog. Laert. in *Aristot.*), that Aristotle served in the capacity of ambassador from the Athenians to Philip, seems inconsistent with other established facts of his life.

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through his father indeed that he lived, but through Aristotle that he lived well."[1]

It would be interesting to know what particular method was pursued by Aristotle in the education of Alexander; but we have no exact information on this point. It appears certain, however, that he made the cultivation of a taste for literature the great principle of his instructions: and this would be in conformity with the plan of education proposed in his treatise of Politics. He is known, indeed, to have made a new collection of the Iliad expressly for the use of Alexander, and to have composed for him a treatise *On the Office of a King*, not extant among his works. How deeply the youthful king had imbibed the Homeric spirit in the discipline of his early years, was evidenced in his after-life, by the heroism with which his actions were conceived, and the poetry which mingled with the realities of his eventful history. The circumstances alone, that the Iliad was constantly at the pillow of Alexander during his expeditions, and was treasured by him with extraordinary care in the precious casket of the spoils of Darius,[2] are characteristic of the tone of mind which his preceptor's instructions had, if not formed, at least strengthened and improved. Nor is it inconsistent with this ultimate effect, that Aristotle should have communicated to his royal pupil even the abstruse doctrines of his philosophy. For, that he did so, we have evidence in Alexander's complaint, in a letter to Aristotle, of the publication of the secret wisdom in which he had himself been disciplined; and in the reply from Aristotle, "that the books alluded to were as if they had not been published, since without his oral instruction they would be unintelligible."[3] Plutarch, indeed, attributes to Aristotle's instructions the fondness for medical study and practice remarkable in Alexander.[4]

A life of such premature exertion as that of Alexander left comparatively little time for the mere business of philosophical instruction. Succeeding to the throne of his father at the age of 20 years, he was from that time immersed in affairs of policy and war; and even previously, he had been forwardly engaged in the services of the field, as also for a short interval in the conduct of the government. Still the society of Aristotle appears to have been cherished by him, so that the philosopher continued a resident at the court for two years after the accession of Alexander; leaving Macedonia only on the occasion of Alexander's setting out on his Asiatic campaigns, B.C. 334.[5] It is probable that Aristotle was indisposed to the hurry and restlessness of military expeditions, and longed for a repose more congenial to his taste in the philosophic bowers of the suburbs of Athens. Circumstances also had prepared the way for the separation. For though Alexander, it seems, never entirely lost his respect for his preceptor, the cordiality of their intercourse had in some measure abated. A commencement of alienation in the feelings of Alexander had been evidenced.[6] Aristotle, accordingly, embraced the opportunity then offered of returning to Athens: and Callisthenes of Olynthus, his relative and pupil, supplied his place among the party of philosophers by whom the king was accompanied in the Asiatic expedition.

It was fortunate for science that the intercourse between the King and the philosopher was not broken off by their separation. The conquests of Alexander presented singular opportunities for a collection of observations on Natural History. Under the superintendence, accordingly, of Aristotle some thousands of persons, it is said, were employed in making inquiries on the subject throughout Asia and in Greece. And we have still valuable fruits of these inquiries, in a *History of Animals*, in ten books, extant among the works of Aristotle; though this history must be but a small part of the fifty volumes to which Pliny says it extended.[7]

In the absence, however, of Aristotle, an event occurred which had the effect of exciting most unjust surmises against him, and involving him in unmerited disgrace with Alexander. A conspiracy was formed against the life of the king by some noble youths who attended on his person. The conspirators were detected and punished. But the chief blame of the whole affair rested on Callisthenes; to whom the education of the youths had been especially committed, and under whose sanction, accordingly, they were conceived to have acted in their traitorous designs. The imputation was the more credible, as Callisthenes had distinguished himself by his opposition to the adulation of the courtiers, and the rude freedom with which, in spite of the admonitions of Aristotle,[8] he asserted his democratic principles. How far he was really guilty may admit a doubt. A pretext at least was afforded for the removal of an obnoxious individual. Callisthenes was imprisoned, and died a violent death. His connection with Aristotle gave a plea for extending the charge to Aristotle himself; who, it is represented, became so fearful of the result to himself, after the death of Callisthenes, as to have been actually instrumental to the murder of the King. He is stated to have sent a very subtle poison, called Stygian water, in a mule's hoof, the only material impregnable to it, to Antipater, and thus to have occasioned the death of the King.[9] The account is sufficiently refuted by the real state of the case, which shews that Alexander fell a sacrifice to his intense exertions in an unhealthy climate. It was probably invented and propagated by the rival sophists who surrounded the person of Alexander. To the same source may be ascribed the first estrangement of the King, and his increased aversion to the philosopher in consequence of the affair of Callisthenes. Alexander pointedly shewed his increased dislike, by sending a present of money to Xenocrates; thus placing that philosopher, as well as Anaximenes, whom he also now more particularly noticed, in triumphant contrast with Aristotle, as the objects of his patronage.[10]

In the mean time Aristotle was pursuing his proper path of exertion at Athens as a lecturer in philosophy, in his own school of the Lyceum. There is no good reason for supposing that he was actuated in forming a separate school, as some

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1 Plutarch in *Alex.* Diog. Laertius in *Aristot.* attributes to Aristotle himself a general expression to the same effect.

2 Plutarch in *Alex.* whence it obtained the name of "the Iliad," εκ του ναρθηκος, "of the casket."

3 Plutarch in *Alex.* Aulus Gellius, *Noct. Att.* xx. 5. This literary jealousy on the part of Alexander appears also from a passage of Aristotle, where, writing to Alexander (*Rhet. ad Alex.* 1), (if the treatise here referred to be really his), he says "you have charged me in your letter that no other person should receive this book."

4 Plutarch in *Alex.*

5 Ammonius, in his *Life of Aristotle*, asserts that Aristotle accompanied Alexander into Asia, and conferred with the Brahmans, where he composed "the two hundred and fifty Polities." How much credit may be attached to this author, appears from his making Aristotle a disciple of Socrates for three years, whereas Socrates had been dead sixteen years before the birth of Aristotle.

6 Plutarch in *Alex.*

7 Plin. viii. 16.

8 Aristotle is said expressly to have cautioned Callisthenes in the words of Thetis to Achilles (*Iliad*, xviii. 95):

Ωκυμορος δη μοι, τεκος, εσσεαι, δι' αγορευεις.

"Quick, indeed, for me, will be thy fate, my son, if such are thy words."

And generally to have admonished him to converse, either very seldom, or else most complaisantly, with the king. Valer. Maxim. vii. 2. Diog. Laert. in *Aristot.*

9 Arrian. *Exp. Alex.* vii. 27.; Plin. xxx. 16; Xiphilin. in *Caracalla*; Qu. Curtius, viii. 6; Brucker, *Hist. Crit. Philos.* in *Aristot.*

10 Diog. Laert. in *Arist.*; Brucker, *Hist. Crit. Philos.* in *Xenocrat.*

have asserted, by contemptuous opposition to Xenocrates, or jealousy of the rhetorical fame of Isocrates.[1] His own fame already stood sufficiently high. Numbers resorted to him for instruction. In the morning and evening of each day he was thronged with hearers; the morning class consisting of his more intimate and peculiar disciples, the evening class of hearers of a more general description. The distinction of these two classes corresponds with the difference between his "acroamatic" or "esoteric" and his "exoteric" philosophy. The application of these terms to the writings of Aristotle has been much controverted. The most simple account of them appears to be, that the acroamatic or esoteric were more of text-books, notices of various points of philosophy to be filled up by the previous knowledge of the learner and the explanations of the teacher, as lectures addressed to his own proper class; the exoteric were more elaborate and popular disquisitions, more expanded in the reasonings, more diffuse in the matter.[2] His disciples obtained the appellation of Peripatetics; but the reason of this is also controverted. Perhaps, like some other party-names, or names of sects, it was originally given in contempt.[3]

The reputation of Aristotle at length rose to a dangerous popularity. The intolerant spirit of paganism viewed with suspicion the spread of philosophical teaching, as tending to unsettle the existing government through their effect on the vulgar superstition. This had been strikingly shown at Athens not long before the birth of Aristotle in the fate of Socrates.[4] In the case of Aristotle there were enemies watching to apply the policy of the state to the cruel purposes which their envy had suggested. For twelve years, it seems, no opportunity of attack presented itself; since he continued his labours at Athens for that time. Probably the name of Alexander had been itself a shelter to him against their malice. But the alienation of the royal favour gave an opening to their designs; and, on the death of Alexander, B.C. 323, he became the marked object of persecution. Through the agency of the hierophant Eurymedon, with whom was associated a powerful citizen, by name Demophilus, a direct accusation of impiety was brought against him before the court of Areopagus. He was charged with introducing doctrines adverse to the religion of Greece.[5] It was alleged that he had paid divine honours both to Hermias and Pythias; to the former by a hymn in praise of his virtue, to the latter by celebrating her memory (for she was then dead) with the Eleusinian rites,[6] and to both by statues of them erected at Delphi. He saw that he had no chance of a favourable hearing against so formidable a conspiracy, and that his death was fully determined by his enemies; knowing too well the malignant sycophancy[7] which domineered at Athens. Instead, therefore, of confronting the charge, he made his escape to Chalcis, alleging to his friends, in allusion to the death of Socrates, "that he was unwilling to involve the Athenians in a second crime against philosophy."[8]

He did not long survive his retreat to Chalcis—little more, probably, than a year. He was then advanced in life, and broken with bodily infirmities as well as with dejection of spirit. On the approach of death, he declared his wish, it is said, with regard to his successor at the Lyceum. Theophrastus of Lesbos and Menedemus of Rhodes were the most conspicuous candidates for that honour. But the dying philosopher, avoiding a pointed rejection of either, delicately intimated his preference of Theophrastus, by calling for cups of Lesbian and Rhodian wine, and, when he had tasted them, simply observing, ἡδίων ὁ Λέσβιος, "*The sweeter is the Lesbian.*"[9] The expression was the more appropriate, as sweetness was the characteristic of the style of Theophrastus.

The mode of his death is variously related. One account is, that he died from vexation at not being able to explain the current of the Euripus.[10] Another story, less incredible than this, asserts that he drank aconite, in anticipation of the adverse judgment of the Areopagus.[11] The only probable account is, that he died from a natural decay of the powers of the stomach, his constitution being worn out by excessive watching and study. How exhaustless his application of mind was, may be judged from the anecdote related of him, that in resting himself on his couch, he would hold a brass ball in his hand in such a way, that the noise of its falling into a basin underneath might disturb him from his slumbers.[12] Another anecdote to the same effect is, that on some occasion of sickness, he observed to the physician prescribing for him, "Treat me not as you would a driver of oxen or a digger, but tell me the cause, and you will find me obedient."[13]

His fellow-citizens showed great respect to his memory. They conveyed his body to *Stagirus*, and erected a shrine and altar over his tomb. In gratitude also for the restoration of their city, effected through his interest with the Macedonian court, and the new code of laws which he had been permitted to frame for them, they instituted a festival called Aristotelea, and gave the name of Stagirite to the month in which the festival was held. Plutarch says that even in his time they showed the stone seats and shaded walks of the philosopher.[14] The grant of a gymnasium had been among the advantages which he had obtained for his native city.

Aristotle was twice married. After the death of Pythias, by whom he had a daughter of the same name, he married Herpyllis, a fellow-citizen. By Herpyllis he had a son, Nicomachus, who became a disciple of Theophrastus, but died in battle at an early age.[15] He adopted also as a son, Nicanor, the son of Proxenus, the friend of his youth, and by the directions of his will gave his daughter Pythias to him in marriage. Pythias, by her third husband Metrodorus, had a son named after the philosopher.

In his extant will we have a pleasing evidence of his amiable concern for his surviving family. It contains affectionate provisions, not only for his wife and children, but for his slaves also; expressly enjoining that no one of those who

1. Diog. Laert. in *Aristot.*; Cicero, *Tusc. Qu.* i. 4: *Orator.* iii. 35; Quinctil. *Inst. Orat.* iii. 1.

2 Aulus Gellius, *Noct. Att.* xx. 5; Plutarch in *Alex.*

3 The practice of teaching in walking was not peculiar to Aristotle (Ælian. *Var. Hist.* i. 19; Diog. Laert. iii. 11; Brucker, *Hist. Crit. Philosoph.* vol. i. p. 788). Indeed the term περιπατον was applied to "discussion" before the time of Aristotle. Aristophanes uses it humorously in *Ran.* 940, 951, in this sense. The custom appears to have been for the hearers to sit at the lectures of the philosophers. Cleon, in *Thuc.* iii. 38, compares the assembly to "persons sitting spectators of sophists."

4 B. C. 400.

5 See Origen. *con. Cels.* i. p. 52, ii. p. 68.

6 The profanation of the mysteries was not an unknown occurrence at Athens. See *Thuc.* vi. 28, 61.

7 Well described by him in a line from Homer, Ογχνη επ' ογχνῃ γηρασκει, συκον δ' επι συκῳ; comparing it, with allusion to the etymology of the word, to the perpetual fruitage of the gardens of Alcinous.

8 Diog. Laert. in *Aristot.*; Ammon. in *Aristot.*; Origen. *con. Cels.* i. p. 51. edit. Cantab.; Ælian. *Var. Hist.* iii. 36; Athenæus, xv. 16.

9 Aulus Gellius, *Noct. Att.* xiii. 5.

10 Justin Martyr, *Coll. ad Græc.*; Greg. Nazianz. *Orat.* iii. p. 79; Bayle, *Dict.* art. *Aristot.* note z.

11 Hesych. in *Aristot.*; Suidas, *Fabric. Bibl. Gr.* vol. ii. p. 109; Diog. Laert. in *Aristot.*

12 Diog. Laert. in *Aristot.*

13 Ælian. *Var. Hist.* ix. 23.

14 Plutarch in *Alex.*

15 Aristocles apud Euseb. *Præp. Ev.* xv. 2.

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had served him should be sold, but that each should be freed on attaining manhood, according to his deserts.[1]

The fondness of the Greeks for apophthegm has handed down some reputed sayings of the philosopher, such as the following:—Being asked "in what the educated differ from the uneducated," he said, "as much as the living from the dead." Again, to the question, "What grows old soon?" he answered "Gratitude;" "What is hope?" "The dream of one awakened." To one boasting that he was from a great city, "Not this," he said, "should one look to, but who was worthy of a great country." "Some men," he observed, "lived so parsimoniously as if they were to live for ever, whilst others spent, as if they were to die immediately." Being blamed for giving alms to a person of no worth: "It was not to the man," he said, "I gave, but to mankind."[2]

In body, Aristotle, if we may believe the accounts of his person, was deficient in the requisite symmetry. He is described as having slender legs and little eyes. To these defects were added a feeble voice and hesitating utterance.[3] Unlike philosophers in general of that age, he attended to the ornament of his person. His hair was shorn; he wore several rings; and was elegant throughout in his dress.[4] His health was infirm; but he sustained it by habits of temperance, and by that medical skill which he possessed in an eminent degree, so as to protract his life to the 63d year, B.C. 322.

Of his moral qualities, the zeal of philosophical rivalry has transmitted the most discordant accounts. Some have been as extravagant in their praises as others have been in their censures. By some, his patriotism, his affection for his friends, and reverence for his preceptor Plato[5]—his moderation, and modesty, and love of truth—have been held up to admiration. By others, again, no crime has been thought too bad to be imputed to him. He has been stigmatized as a parasite, as gluttonous, effeminate, sordid,[6] ungrateful, impious. Among his faults, too, have been mentioned a sneering cast of countenance, and an impertinent loquacity. In particular, he has been accused of assailing Plato with captious questions, and forcing the old man, when in his 80th year, to retire to the privacy of his garden.[7] Whilst, however, the circumstances in which he lived, exalted as he was by the favour of kings, and by eminence in philosophy, afford a strong presumption that the dark side of the picture has at least been overcharged,[8] we have a more decisive evidence to the truth of the favourable representations of his character in the temper and spirit of his extant writings. Throughout these, there is a candour, and manliness, and love of truth, strikingly discernible; not professedly set forth, but interwoven with the texture of his discussions, and rather betrayed unconsciously than obtruding itself on our notice, and demanding to be recognized. His ethical writings, especially, breathe a pure morality, such as we find in no antecedent philosopher; a morality also avowedly practical, and by which he would have stood self-condemned had his own conduct been at variance with it. (R. D. H.)

ARISTOTLE'S PHILOSOPHY.

Account of the Writings of Aristotle, and reception of his Philosophy.

The preservation of the original copies of the writings of Aristotle is a curious fact in literary history. Whilst the philosopher distributed his other property to his surviving family, he left the more precious bequest of his writings to Theophrastus, his favourite disciple and successor in the Lyceum. By Theophrastus they were bequeathed to Neleus, his scholar, by whom they were conveyed from Greece into Asia Minor, to the city of Scepsis, where he resided. The heirs of Neleus, to whom they next descended, were private individuals, not philosophers by profession, who were only anxious for the safe custody of their literary treasure. The magnificence of kings had then begun to display itself in the collection of libraries, and the works of genius were sought out with an eager and lavish curiosity. It was a taste happy for the cause of literature; to which, perhaps, the example of Alexander's noble fondness for everything connected with intellectual energy had principally led. Aristotle himself, indeed, is said to have been the first to form a library.[9] He was the first, probably, to form one on an extensive scale. The Scepsians, into whose hands his works had now fallen, fearful of the literary rapacity of the kings of Pergamos, resorted to the selfish expedient of secreting the writings under ground. The volumes remained in this concealment until at length their very existence seems to have been forgotten; and they would thus have been lost to the world, but for the accidental discovery of them after the lapse of 130 years. His philosophy had been traditionally propagated; for we hear of Peripatetics at this time. Portions, indeed, of his works must doubtless have continued in circulation among the disciples of the Lyceum, serving in some measure as a record of the principles of the sect. Much may have been preserved from memory: for we have little notion now of the impression made by *viva voce* instruction, when it was the only channel of knowledge to the generality. A Peripatetic philosopher, accordingly, Apellicon of Teos, whom Strabo, however, characterizes as a lover of books rather than a lover of science—*φιλοβιβλος μαλλον η φιλοσοφος*[10]—purchased the recovered volumes, and effectually retrieved them for the world. He employed several copyists in transcribing them, himself superintending the task. Unfortunately, much was irreparably lost, the writings being mouldered with the dampness of the place in which they had so long been deposited. In addition to these damages of time, they were now further impaired by misdirected endeavours to restore the effaced text of the author.

The works of Aristotle, or rather the copies of them thus obtained, were conveyed by Apellicon to Athens, their proper home, though no longer perfect in the text or such exactly as the author had left them. Here this collection of them remained until the spoliation of the city by Sylla. The library of Apellicon was a tempting object of plunder to the Romans, who were now awakened to the value of literature; and Aristotle's works accordingly were carried away to Rome amidst the other rich spoils. At Rome they experienced a better fortune. Tyrannio, a learned Greek, who had been

[1] Diog. Laert. in *Aristot.*.

[2] Diog. Laert. in *Aristot.* The same author mentions an instance of Aristotle's foiling the cynic Diogenes in some premeditated witticism, and gives some expressions by which Aristotle characterized certain philosophers, such as calling Socrates "a shortlived tyranny." The point of these passages, at any rate, escapes the modern reader.

[3] Diog. Laert. *τραυλος την φωνην.*

[4] Diog. Laert.; Ælian. *Var. Hist.* iii. 19.

[5] Ammonius says he dedicated an altar to Plato, inscribing it to him as "a man whom for the bad even to praise would be profane."

[6] Hence the story of his selling the oil which he had used medicinally about his person. (Diog. Laert. in *Aristot.*)

[7] Ælian. *Var. Hist.* iii. 19.

[8] See Aristocles apud Euseb. *Præp. Ev.* xv. 2.

[9] Strabo, xiii. The account given by Strabo has been much canvassed by modern critics.

[10] *Ibid.* xiii. p. 609. Aristocles in Euseb. *Præp. Ev.* xv. 2, speaks of Apellicon as the author of some writings on Aristotle.

a prisoner of war to Lucullus, and was then enjoying the freedom granted to him as a resident at Rome, was the principal instrument in their future publication. Obtaining access to the library of Sylla, he made additional copies of the writings. His labours were followed by Andronicus the Rhodian, who at length edited the collected works of Aristotle, at a distance of nearly 300 years from the time when they were composed.[1]

Meanwhile other sects in philosophy had sprung up, and engaged the attention of the world. The Stoics and the Epicureans, among others, had formed their respective parties. Platonism had obtained permanent establishment at Alexandria. The disciples of Aristotle, on the contrary, had to struggle against the disadvantage of the loss, except, it seems, in some detached portions, of the authoritative records of their master's philosophy. When, however, these records were fully published, they were studied with extraordinary eagerness. A multitude of commentators arose, who exercised their acuteness and ingenuity in explaining the sense of the philosopher. As Aristotle himself by his personal teaching had transcended the fame of his contemporaries, so his philosophy rose up from its long sleep to triumph over every other that had previously engaged the public mind. Platonism, indeed, modified as it was by Ammonius and his successors, continued to be fostered in the early ages of the Christian church, in consequence of the theological cast which it had assumed, and its facility of accommodation to Christian truth. But in the progress of the Church, when Christianity needed to be maintained, not so much by accession from the ranks of paganism, as by controversial ability within its own pale, a more exact method was required. Here, then, the philosophy of Aristotle asserted its value and its pre-eminence.

But it was only a partial Aristotelic philosophy that was at first established. His logical treatises had been studied during the ascendancy of Platonism, for their use in arming the disputant with subtle distinctions, and enabling him accurately to state his peculiar notions in theology. The same occasion still existed for the acuteness of the expert logician, even after the decline of Platonism, in the state of theological controversies. It was still, therefore, chiefly as a logical philosopher, through the several treatises which pass under the name of the *Organon*, that Aristotle was known throughout Christendom. In the west of Europe, indeed, the cloud of ignorance which had covered the lands with thick darkness, limited the attainments even of the learned to a narrow field. The original language of Aristotle's philosophy was gradually almost forgotten; and the generality were restricted to such of his writings as were translated by the few learned men, the luminaries of the long night of the middle ages. The peculiar exigencies of the times, and the taste of the learned themselves, led to the translation in particular of the logical treatises. That on the Categories appears to have been the one principally known among Christians. Nor were these translations always made from the original Greek; but, on the contrary, were in most instances versions of versions. For its knowledge of Greek literature, the west of Europe was indebted to Arabian civilization. The Arabians had, together with their conquests in Spain, imported their knowledge of the Greek philosophy, the seeds of which had been scattered in the East by the learning of the Nestorian Christians. Translations had been made into Arabic, of the Greek authors, and among these, of Aristotle. Jews at the same period were resident in great numbers in Andalusia, the principal seat of Arabic literature. These, by their commercial intercourse with Christians and Mahometans, served as a channel through which the Greek philosophy was carried on from the Spanish Arabians to the Christians of the West. For the purpose of communication, the Arabic versions of Aristotle were translated into Latin, the universal language of early European literature. And thus was the foundation laid of that Scholastic philosophy, through which the dominion of Aristotle was afterwards extended over Europe.

But the occupation of Constantinople by the Latins, in the beginning of the thirteenth century, was the opening of a new era in the literary history of Europe. Greater facilities were afforded by this event for the knowledge of the Greek language. Aristotle began then to be no longer known chiefly as a logician. His physical, metaphysical, and moral treatises were more extensively explored and studied; though at first objection was made to the Physics by the Papal authority. He was thenceforth recognized under the title of *Princeps Philosophorum*. His logic, indeed, maintained its ascendancy in the Schools of Europe; but it was not applied exclusively, as at first, to Theology. It was carried into those new subjects of inquiry which the extended knowledge of his writings had introduced to the learned. The spirit of disputatious subtilty, which, in the beginnings of the Scholastic philosophy, had displayed itself in the quarrels between the Nominalists and Realists, afterwards found employment in the application of logical principles to speculations in physics and metaphysics. At the same time Theology became more and more corrupted by the refinements of systematic exposition; until at length the accumulated mass of error became too evident to be borne, and, among other causes, produced a re-action in the Reformation of the Church.[2]

The abuse of his philosophy, thus manifested, tended greatly to shake the empire which it had held over the minds of men. Had Luther, accordingly, stood alone in the work of reform, Aristotle would perhaps have been altogether banished from the schools of the Reformed. But his roughness of hand was tempered, in this point as in others, by the milder spirit of Melanchthon.

Melanchthon, whilst he had too deep an acquaintance with classical literature not to feel the charm of the writings of Plato, justly vindicated the superiority of Aristotle's philosophy as a discipline of the mind. He therefore assisted in supporting the established dominion of Aristotle in the Schools; whilst he rejected the errors to which it had administered.[3] Afterwards the disputes among Protestants themselves served to perpetuate that dominion: and, from the same cause as before, the subtilties of the Logical and Metaphysical treatises were studied rather than the more practical parts of the philosophy. Thus, even after the labours of Bacon in dispelling the mists which the too elaborate study of Aristotle's system and method by the doctors of the Middle ages, had diffused, his works continued to be read and taught in Protestant Universities. His philosophy, during an empire of centuries, had occupied so many posts in the field of science and literature, that no other, however

[1] Plutarch in *Sylla;* Bayle's *Dict.* art. Tyrannio, note D; Brucker, *Hist. Crit. Philos.* vol. i. p. 799. Andronicus flourished about B.C. 60. The rise of philosophy at Rome was contemporary with him. Cicero in *Tusc. Qu.* i. 1, says, "Philosophia jacuit usque ad nostram ætatem." He speaks, too, in *Fin.* iii. 3, of finding "commentarios quosdam Aristotelios," in the villa of Lucullus. Athenæus, i. p. 3, says the books of Aristotle were purchased of Neleus by Ptolemy Philadelphus, for the library of Alexandria. This may also be true of detached portions of Aristotle's works, or copies of such portions.

[2] Roger Bacon, *Opus Majus*, part i. p. 13, 19, ed. Jebb, Lond.; Lewis's *Life of Wickliffe;* Lewis's *Life of Bishop Pecock;* Mosheim's *Eccles. Hist.* vol. ii. p. 216, 218, Lond. 1823; Pegge's *Life of Bishop Grosseteste; Recherches Critiques sur l'Âge et l'Origine des Traduct. Lat. d'Aristote*, par M. Jourdain, p. 16, 81, 94, Paris, 1819.

[3] Melanchthon in *Aristot. et Platon.* ii. p. 370, iii. p. 351; Bayle's *Dict.* art. Melanchthon, note K.; Brucker, *Hist. Crit. Phil.* iv. p. 282.

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great the improvement, could at once displace it. For thus we find even Bacon himself, in the process of counteracting it, and introducing his "Interpretation of Nature," compelled to use a phraseology founded on the dogmas of the Schools.

It is then of great importance to examine the system of Aristotle in its own authentic sources. Such an examination will convince us, that the philosopher is not to be censured for that depravation of philosophy to which he was made subservient; but rather that, had his teaching been rightly applied, and pursued in the spirit of its author, the Schoolmen could hardly have been led into those airy and unreal speculations which constituted their science of Nature. We are compelled, indeed, to take our estimate of it from such imperfect and often confused relics as time has spared to us out of a far greater mass of his original writings.[1] Fortunately, however, those relics include a great variety of treatises, affording a specimen at least of his mode of philosophizing in every department of science.

State of Philosophy before Aristotle. General Character of his Philosophy.

Aristotle was the first who really separated the different sciences, and constituted them into detached systems, each on its proper principles. Before his time philosophy had existed as a vast undigested scheme of speculative inquiry, fluctuating in its form and character according to the genius and the circumstances of its leading teachers.

Thus the two great fountains of Grecian science,—the Italic school, founded by Pythagoras—the Ionic, by Thales—were both in principle mathematical; though, when we look to their actual results, as they were moulded by their respective masters, the Italic is characterized as the Ethical school, the Ionic as the Physical. Both appear to have been drawn from the same parent-source of Egyptian civilization and knowledge. The mystic combination of mathematical, physical, and moral truth exhibited in the ancient theological philosophy of Egypt, found a kindred spirit in Pythagoras. Hence that solemn religious light shed over his speculations. Mathematical science was the basis of his system. He conceived Numbers to be the primary elements of all things; regarding all other objects of thought as "imitations," or "representations," of Numbers.[2] But the system, as a whole, was a mystic contemplation of the universe, addressed to the moral and devotional feelings of man. Thales was a philosopher of a much more simple cast. Like Pythagoras, he was devoted to mathematical study. He is said to have instructed the Egyptians how to measure the height of their pyramids by means of the shadows; and several of the theorems of the Elements of Euclid are attributed to him. But he did not, like Pythagoras, fall into the error of confounding and blending the objects and facts of the external world with the truths of abstract science. According to him, it was sufficient to shew that water was the element of all things. He sought no deeper cause in any speculation concerning the mode in which this element subsisted. The successors of Pythagoras and Thales variously modified the theories of those great masters. The physical philosophy, however, of Thales, as the more simple and intelligible, and probably also from the greater intercourse of Greece with its Asiatic colonies than with its Italian, especially prevailed in Greece. Thus we find Socrates, who had been the disciple of Archelaus of that school, complaining that the concerns of human life had been abandoned for the subtilties of physics. In the hands of Socrates philosophy resumed its moral complexion. Had it devolved on Xenophon to take the lead as the successor and interpreter of Socrates, things would probably have continued in this course, and ethical science might henceforth have triumphed in the Grecian schools. But the genius of Plato succeeded to the rich patrimony of the Socratic philosophy. And Plato was not one whose ambition could be content with less than the reputation of founding a school, or whose imagination could be tied down to the realities of human life.[3] The mystical theory of Numbers taught by Pythagoras possessed a powerful charm for such a mind as that of Plato. At the same time his power of eloquent discussion found its own field of exertion, in speculaing on those moral truths with which the lessons of Socrates had inspired him. He had also been a hearer of Cratylus,[4] and through him had been instructed in the theory of the "perpetual flux" of nature, the great doctrine of Heraclitus. Plato accordingly applied himself to the combination of these various systems. The theory of Pythagoras was to be retained consistently with the perpetual change of all existing things according to Heraclitus, and with the immutability of nature implied in the Socratic definitions. Definitions could not apply to any perceptible objects, if it were allowed that all such objects were constantly changing. Nor could Numbers sufficiently account for that immense variety of objects which the universe presented. There must therefore, it was concluded, be some existences, independent of the perceptible universe, the fixed objects of definitions; and there must be also an infinity of various archetypes, corresponding to the various classes of external objects. Hence he devised his doctrine of ειδη, or Ideas; a doctrine naturally suggested to an imaginative mind, by the fixedness and universality of the notions signified by language, as contrasted with the perpetual variations of the external world. To these abstract natures, or Ideas, he assigned a real being, as objects of intellectual apprehension; accounting for the existence of sensible things from their "participation" of them. Thus he raised a structure of philosophy on a basis of metaphysics and logic conjointly; or, in other words, Philosophy, in its passage through the school of Plato, had become a transcendental Logic or Dialectic. Dialectic, the science, according to Plato, which contemplates the Ideas themselves, was held forth to the student as the dominant philosophy, the consummation and crown of all sciences.[5]

Such was the state of Philosophy when Aristotle began to teach, and in which he had himself been trained. But it was not a system in which his penetrating mind could rest satisfied. He thought too accurately, not to discover that this cardinal doctrine[6] of Platonism, the doctrine of Ideas, specious as it was, was only a shadowy representation of the objects of philosophy;[7] and that, in order to rest the sciences on a sure basis, a more exact analysis of the principles of human knowledge was required. He accordingly addressed himself to the task of developing a *really intel-*

[1] Diog. Laert. in *Aristot.* συνεγραψε δε παμπλειστα βιβλια.

[2] *Metaph.* i. 6, ii. p. 848, Du Val. *Metaph.* xii. 3. p. 974.

[3] Aristotle (*Rhet.* ii. 23) mentions that Aristippus, alluding to Plato's ambitious manner of expression on some point of philosophy, remarked, αλλα μην δγ' εταιρος ἡμων, ουδεν τοιουτον, "our friend, at any rate (meaning Socrates), has nothing of the kind."

[4] Cratylus found fault with his master Heraclitus for saying that "a man had never been twice on the same river; for no one," he said, "had ever been even once." (*Metaph.* iv. 5.) This was but a natural extension of the doctrine of Heraclitus.

[5] Αρ' ουν δοκει σοι, εφην εγω, ὡσπερ θριγκος τοις μαθημασιν ἡ διαλεκτικη ἡμιν επανω κεισθαι, και ουκετ' αλλο τουτου μαθημα ανωτερω ορθως αν επιτιθεσθαι, αλλ' εχειν ηδη τελος τα των μαθηματων; Εμοιγ' εφη. (Plato, *Republ.* vi. p. 400, ed. Bekker.)

[6] Το δε κεφαλαιον και το κυρος της Πλατωνος αἱρεσεως, ἡ περι των νοητων διαταξις. (Atticus Platonic. apud Euseb. *Præp. Evan.* xv. c. 13.)

[7] Τα γαρ ειδη χαιρετω· τερετισματα γαρ εστι. (Aristot. *Anal. Post.* i. c. 22.)

lectual system of nature, in the stead of that imaginary world of thought and knowledge which the lofty enthusiasm of Plato had created.

He found the several sciences separated from their roots, and vegetating only as stunted branches on a stock unnatural to them. Even Dialectic itself, the master science, was neglected. Its proper nature was mystified and overlooked in that medley of logical and metaphysical truth which had usurped its name; and its relation to the other sciences was misapprehended. In overthrowing the doctrine of Ideas, therefore, he had to make an entire reform of philosophy. And, in fact, he did appear no less as a reformer of the ancient philosophy, than Bacon was of the scholasticism of his day. In each case, idols were enthroned in the niches and shrines of the temple of science; and the hand of a bold reformer was required to cast them down and break them in pieces. If indeed we impartially consider the case, we shall find that Aristotle was animated by the like spirit to that which dictated the method of the Inductive philosophy, and that his reform was directed to the like points. It was his object, as well as Bacon's, to recal men, from their unprofitable flight to universals, to a study of the actual course of nature; and further to direct them into the right path of discovery.

He was the first, accordingly, except in the case of Mathematics, to exhibit a particular science drawn out into its proper system. There was, for instance, a great deal of logical and of moral truth scattered through the writings of Plato: but there was no regular statement of the principles either of logical or moral science, no distinct collection of the proper facts of those sciences, until the treatises of the Organon and the Rhetoric and Ethics of Aristotle appeared. We may easily conceive the arduousness and importance of this service in the cause of philosophy. For any one person to have fully carried into effect such a design, might well be thought impossible. And we shall not wonder, therefore, that in some instances he should have failed, or have merely indicated the proper method to be pursued.

It was not indeed to be expected, that one trained in the dialectical philosophy of Plato should have emerged at once from the prejudices of that system. Aristotle, though professedly opposed to the realism involved in Plato's doctrine of Ideas, yet betrays the power of language over his own speculations, by the importance which he attributes to abstract notions as the foundations of scientific truth. It is a delusion, which the simple attention to the phraseology of one language (and there is no evidence that Aristotle knew any language but his own) is apt to produce. In the analysis of words, we are apt to lose sight of the merely arbitrary connection between them and the objects designated by them, and to suppose that we have penetrated into the nature of the thing, when we have only explored the notions signified by the term. Thus Aristotle, whilst he rejected the Platonic theory of Ideas, still conceived that there were certain immoveable principles, in the knowledge of which true science consisted. He differed at the same time from Plato in his estimate of their nature. Plato regarded the Ideas as archetypes and causes of all sensible and actual existences; whereas Aristotle contemplates them simply as causes or first principles from which all knowledge is derived. He did not allow that these abstractions had in themselves any objective reality or any active power; but he conceived that the speculation about them was an insight into the secrets of Nature.

Philosophy, accordingly, under his hands, stripped of its metaphysical mysticism, assumed a strictly logical aspect. The foundations of science were laid in definitions of those essential natures which constituted the first principles of his system; and from these definitions the truths of the particular sciences were to be deduced.

From this view of the nature of science, it followed that he should employ Induction, rather to determine notions, than to arrive at general principles, such as in modern philosophy are denominated Laws of Nature. In order to discover a first principle, on which a system of science might be raised, it was necessary to state exactly that conception of the mind which belonged exclusively to any particular class of objects. The stating such a conception was, in the phraseology of Aristotle, the assigning of the λογος of the ουσια, or the giving a definition of the object as to its essence. A definition of this kind required an accurate analysis of thought. Every notion common to other objects was to be rejected; and after such rejection, that which remained exclusively appropriate to the object under consideration, was to be assumed as the principle by which its real nature was expressed. The process was not dissimilar to that by which the truths of modern science are elicited; except that the Induction of Aristotle terminates in universal notions; whereas the Induction of Bacon terminates in general facts;—such facts being the utmost that can be obtained from outward observation of objects. It is precisely indeed in this point that the great difference consists between the science of Aristotle and that of Bacon. Aristotle, for example, inquires into the nature of light, and endeavours to define it exactly as it differs from all other natures. This definition is an expression of that principle on which the whole nature of light is conceived to depend. A modern philosopher pursuing the method of Bacon, examines facts concerning it, and, distinguishing those which really belong to it from those which do not, concludes from the remainder some general affirmative respecting it. A modern philosopher often draws a conclusion as to the nature of a thing; as when he infers that light is material, or that the soul is immaterial. But then he does not hold such inferences as principles in the sense of Aristotle; nor does he employ them to interpret the facts of a science. He acquiesces in such conclusions as ultimate principles. He finds, for example, the facts belonging to the falling of bodies on the earth's surface, and to the revolutions of the heavens, coincident in the same general law. He pronounces, therefore, that the principle signified by the term gravity, whatever its nature may be, is the same in both classes of facts. His conclusions at the same time in Natural Philosophy are independent of this assumption; as these would not be affected, though the principle of gravitation were proved to be different in the two cases. If you overthrow, on the other hand, a speculative doctrine of the ancient physics, all the conclusions of the system fall to the ground.

We shall wonder the less at the peculiar complexion of Aristotle's philosophy, when we observe that even modern philosophers have been by no means exempt from the realism which language tends to suggest, and which might almost be termed the original sin of the human understanding.

Such, then, according to Aristotle, was the character of philosophy, so far as it was purely theoretic. It furnished the mind with the means of contemplating nature surely and steadily, amidst the variety of phenomena which external objects presented, by fixing it on abstract universal principles, eternal and unchangeable.

But this was not the only view which he took of philosophy. He did not limit its use to contemplation; though contemplation was its proper function. He regarded it further under two other distinct points of view—as it studied the principles either of effects produced, or those of human actions. Thus, he distributes philosophy in general into three branches: I. Theoretic; II. Efficient; III. Practical. By Theoretic, he denotes 1. Physics, 2. Mathematics, 3. Theology, or the Prime Philosophy, or the science known by the

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modern name of Metaphysics; by Efficient, what we understand by the term Art, as Dialectic or Logic, Rhetoric, Poetics; by Practical, Moral philosophy, as Ethics and Politics. Whilst, then, in order to a purely Theoretic philosophy, he endeavoured to present to the mind the primary elements of thought, following the order and connections of human reason rather than looking to the phenomena of nature, he had a different aim in the two other branches of inquiry, and pursued a different method. In these, his aim was to enable the student to realize some effect, or to attain some good; in Efficient Philosophy, to lay before the mind those principles which impart skill in the arts; in Practical, those by which the goods of life are attained, whether by individuals or by societies. Thus, in both these branches his object, though comparatively limited, was in fact the same as that of Bacon—to increase human power by increasing human knowledge. He has accordingly adopted, in pursuing them, the Inductive method. We find him in these strictly attending to Experience—deducing his speculative principles from facts, and pointing out their application to the purposes of the arts and the business of life. Under the term τεχνη, indeed, which we translate Art, he comprised much more than is understood by Art. Chemistry, for instance, might justly be referred to this branch of philosophy, so far as its principles are applicable to the production of any effect. In fact, it corresponds more nearly with Science, in the acceptation of the word by Bacon, or to what is understood by the term "applied science." For Aristotle himself expressly asserts it to be the result of Experience—observing, that memory of particular events is the foundation of Experience, and that from several experiences Art is produced.[1]

So also, in his Practical philosophy, he directs us not to seek a speculative certainty of principles, but to be satisfied with such as result from the general experience of human life. He further even gives express caution against treating this department in the *a priori* method of his Theoretic philosophy, in remarking that the abstract speculation concerning universal good was unprofitable in that kind of inquiry.[2] Had he viewed Natural Philosophy in its application to the arts, he would surely have introduced the Inductive method there also. Indeed he has done so, wherever particular departments of nature are explored in his writings in order to particular arts. But his works professedly treating of Natural Philosophy belong to a higher speculation, according to his estimate, than those which concern human life. He conceived the things of the material world to be unoriginated and indestructible in their essential nature, and *therefore* the eternal objects of scientific truth,[3] whilst every thing belonging to man was temporary and variable. The former, therefore, were not satisfactorily investigated until they were referred to their primary fixed principles; but of the latter it was sufficient to obtain such knowledge as the contingency of the objects admitted. He perceived, from his accurate and extensive knowledge of human nature, that there was no ground for that realism in Morals which the more uniform aspect of the physical world tended to inculcate. The immense variety of objects to which the appellation of "good" was applied, impressed on his acute mind the conviction that there was no one fixed and invariable principle implied by that term; and that the truths of Moral Philosophy, accordingly, were to be sought simply in an observation of facts, without endeavouring to trace the general facts thus collected to some further abstract principles.

It will illustrate this arrangement of the sciences to look to the Theory of Causation, or the several classes into which Ancient Philosophy distributed the principles of scientific investigation. Now, the classes of such principles assigned by Aristotle are, 1*st*, The Material, or that class which comprehends all those cases in which the inquiry is, *out of* what a given effect has originated. From the analogy which this principle has to the wood or stone, or any actual matter, out of which a work of nature or art is produced, the name "Material" is assigned to the class. But it is not commonly so termed by Aristotle, whose description of it is more precise and just.[4] Unfortunately the term "Material" introduces a misunderstanding on this head. It may be supposed to mean something physically existing, some sensible matter, as wood or stone; whereas, according to Aristotle, it denotes antecedents; that is, principles whose inherence and priority is implied in any existing thing.[5] The Material cause, then, is properly an intellectual principle—one of the elements into which the mind resolves its first rough conception of an object.

The second class of Causes is that to which all inquiries belong which respect the Characteristic nature of a thing. To this Aristotle gives the name of ειδος, form or exemplar.[6] It corresponds with what are termed in modern philosophy "laws of nature." According to Aristotle, and the ancient philosophy in general, it is the abstract essence or being of a thing,—that primary nature of it on which all its properties depend. Bacon, indeed, has retained the name "Form" in his *Organum*, and applied it to denote the generalizations of his philosophy;[7]—a general fact, from its excluding all merely accidental circumstances, being in a manner the proper *form* of the particular facts from which it is inferred, under all the variety which they may exhibit.

The third Class of causes comprehends all inquiries into the Motive or Efficient principles of a thing. It differs from the Material cause—which it resembles so far as it is an investigation of antecedents—in its reference to such antecedents only as are the Means in order to an Effect. We may contemplate a given effect *as such*, and not simply as a mere *event;* and in that case we inquire into the *power* by which it was produced, or the Motive cause. It is to this class that the term Cause[8] is popularly applied, by analogy from the works of human art, in which we discern the connection between means and results. Aristotle, however, did not suppose that we could discover such necessary connection in Nature; signifying by such a cause merely those principles under which all effects, *as such*, might be arranged.

The fourth class in the ancient theory of Causation is what has obtained the appellation of the Final Cause, or, to express it more after the mind of Aristotle, Tendency, or an account of anything from a consideration of its perfect nature or tendency. For example, when we appeal from virtue militant in the world to virtue triumphant in heaven, and explain the present state of moral disorder, by this ultimate view of virtue, or of the end to which it is tending, we argue from a Final Cause in the sense of Aristotle. So, again, when it is argued that the eye was formed for seeing, because its nature is *perfected* in the act of seeing; or, in general, whenever it is inferred that such is the nature of a

1 *Metaph.* i. 1; *Analyt. Post.* ii. last chap.
2 *Mag. Mor.* i. 1; *Eth. Nic.* i. 6.
3 *Aalyt. Post.* i. c. 8; *Ethic. Nic.* vi. 7.
4 *Nat. Ausc.* ii. c. 3, το ἐξ οὗ γινεται τι ἐνυπαρχοντος, ii. c. 7. *Analyt. Post.* ii. c. 11, p. 170, Du Val. το τινων οντων αναγκη τουτ' ειναι.
5 The premises of a syllogism accordingly are the material cause of the conclusion.
6 Thus he terms it also παραδειγμα, *Nat. Ausc.* ii. 2, Du Val. i. p. 330, the pattern, as it were, of the thing, or its archetype, in the mind.
7 Bacon, *Nov. Org.* ii. 2.
8 The word *cause* is indeed, as has often been pointed out, only a verbal generalization of the different principles to which it is here applied. The Greek word αιτιον, "account," or "reason why," is nearer the truth.

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thing, because it is *best* that it should be so. According to modern views, Design is always implied in a Final cause. In Aristotle, it is an intrinsic Tendency in Nature, analogous to the effect of Design.

The division of Philosophy adopted by Aristotle corresponds with this classification of Causes. Physical science, as concerned about objects, of which one rises out of another, or is produced after another, is an investigation of Material Causes. The inquiry is into the law of continuation and succession observed in the natural world,—what the antecedents are in this course,—what the primary principles into which the succession of physical events may be resolved.

The First Philosophy, including Theological, Metaphysical, and Mathematical science, belongs to the Formal Cause. It endeavours to draw forth that secret philosophy by which the mind administers the world of its own ideas; and, by this process to arrive at those primary abstract forms which are the originals, and patterns, as it were, of the various actual forms of things throughout the universe.

Dialectical science, and the Arts in general, are inquiries into Motive Causes, since it is by the Arts that human power is exerted in producing certain effects. The principles of Rhetoric, for instance, are the means by which persuasion is effected. In order to produce any effect, we must observe what acts, what moves, what influences—not simply what precedes or follows in the order of nature; and a study of this kind constitutes what Aristotle calls Efficient philosophy.

The Final cause is the science of human actions, or Practical philosophy. Actions, being the exertions of the inward principles of our moral constitution towards some end, cannot be rightly estimated by viewing them merely as effects, but must be considered in their design or *tendency*. A compassionate action, for example, may, in its actual effect, be productive of evil; but we cannot conclude as to the *nature* of the action from this result. We must further inquire, whether the result was coincident or not with the effect intended, or what it would have been, had the action been perfect as the exertion of the principle; that is, we must inquire into its Final cause.[1]

But though this is the appropriate classification of the principles of the several sciences, it does not follow that any particular science is restricted to one particular mode of speculation.[2] The several kinds of Causes are all employed as modes of analysis under the same head of philosophy.[3] As all philosophy, indeed, ultimately refers to the principles of the human mind, so far every science is a speculation of the formal cause. In Aristotle's system of Physics, the speculation of the Final Cause occupies the *principal* place, instead of being employed, as in modern philosophy, in subordination to the inquiry into the Material and the other Causes.

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Physics, Mathematics, Metaphysics.

In proceeding to examine the several sciences included in this threefold division of Philosophy, and contained in the extant writings of Aristotle, those which he has classed under the head of Theoretic philosophy, as being the only *proper sciences* in his view, naturally come first to be considered. These, then, are Physics, Metaphysics (or Theology), and Mathematics.

There is the less occasion for considering these sciences distinctly, as Aristotle has not strictly maintained their separation, but has often blended their different principles in the same discussion. In this department of philosophy he receded less from the dialectical system of Plato, and felt the influence of that system attracting him into its vortex. As Plato, by drawing off the attention of the philosophical inquirer from nature itself to the Ideas of his intellectual world, was led to confound all the sciences in one philosophical reverie; so Aristotle, in the Theoretic branch of his philosophy, looking to the primary principles of the sciences as they exist in the human mind, rather than to the phenomena of each, overlooked their real differences in his mode of treating them. The ground of this promiscuous discussion is to be found in that classification which he adopts of the objects of these three sciences.[4] They are all, in his view, conversant about *τα οντα*, or things that ARE; but differing in the mode in which they abstract the notion of BEING from existing things. The science which considers Being in union with matter, or as it is evidenced under those variations which the material world presents, is Physics. That which considers Being as it is conceived apart from the variations of the material world, though still not separate from matter, is Mathematics. Lastly, that to which the name of Metaphysics has been given by his commentators, but to which Aristotle himself assigns the name of Theology, or the First Philosophy, is the science which considers Being apart both from the variations of the material world, and from matter. It appears, therefore, that the object of his inquiry in each of these three sciences is ultimately the same. He is engaged in all, in investigating those universal principles under which existing things are arranged by the mind. For this is the meaning of the term Being in his Philosophy. It stands for any of those conceptions by which the various natures or properties of things as they exist, are represented in the mind. These sciences, accordingly, not differing fundamentally in his view, he was naturally led to combine them in one general speculation.

Hence the abortive and futile character of his Physical philosophy. Instead of looking to the phenomena of the material world, he was employed in arguing from metaphysical and mathematical data, from mere abstract notions, to the realities of external nature. Thus, instead of being an investigation of the laws of nature, his system was a vain fabric of speculative reasoning from assumed principles. Whilst he thought that he was discussing and stating truths of physical science, he was only analyzing certain notions of the mind, and accurately defining them. No other method, indeed, is open to the philosopher, who would penetrate the veil of the actual phenomena, and establish a certainty of science beyond what is conceded to man, but that of abstract Definitions. These being once laid down, the truths of science follow by necessary connection; for they are then the mere development of general assertions into the particulars implied in them, or connected with them. But, the cer-

[1] The same principle applies to the arts also, so far as the skill in any art is exerted in action. We then judge of the art so exemplified by its tendency to produce the *proper* effect; of the wisdom, for instance, of the politician by the adaptation of his counsels to the welfare of his country—or of the military skill of the general by his plans—not simply by their result; which may accidentally be untoward.

[2] *Nat. Ausc.* ii. 7, *επει δε αιτιαι τεσσαρες, περι πασων τȣ φυσικȣ ειδεναι· και εις πασας αναγων το δια τι, αποδωσει, φυσικως, την ὑλην, το ειδος, τȣ κινησαν, το ȣ̔ ἑνεκα. ερχεται δε τα τρια εις το ἑν πολλακις· κ. τ. λ.*

[3] Thus an action may be analyzed into the affection exerted in it (the material or physical cause), the choice of the agent (the motive cause), the end to which it tends (the final cause), the definition of the virtue to which it belongs (the formal cause); and yet the science of the action is fundamentally an inquiry into the final cause.

[4] *Metaph.* vi. 1, and xiii. chap. 1, 3, and 4. See also *Nat. Ausc.* ii. c. 2.

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tainty and necessity of such conclusions are nothing more than consistency with the original assumptions. It would be absurd to suppose them otherwise, because this would be to contradict what has been already asserted. Aristotle indeed expressly says, that truth of fact and truth of science are not mutually implied in each other. "Impossible and possible, and falsehood and truth," he observes, "are either hypothetical—as it is impossible for a triangle to have two right angles, if this is so, and the diameter of a square is commensurate with its side, if this is so,—or absolute. But absolute falsehood and absolute impossibility are not the same; since, for one not standing to say he is standing, is false, but not impossible; and for a harper not singing to say he is singing, is false but not impossible; but to stand and sit at once, or for the diameter to be commensurate, is not only false, but impossible."[1] Still he sought to unite both kinds of truth in his physical speculations; and in the vain attempt, lost sight of the absolute truth contained in the facts presented to his observation.

The first portion of his Physics, contained in a treatise in eight books, entitled *Natural Auscultations*, is devoted to inquiries into principles; with a view to ascertain those fundamental conceptions from which all conclusions concerning physical objects were, in the *a priori* spirit of the whole inquiry, to be deduced. Agreeably to this order, he sets out with discussing the question, whether these principles should be ultimately referred to one or more than one, and laying down his own doctrine of three principles, under the established denominations of, 1. Matter, 2. Form, 3. Privation. These are the principles which, as employed by his disciples of the middle ages, have occasioned much undue censure of the philosopher. His system, indeed, is sufficiently condemned in its hypothetical character, but is guiltless of the absurdity which modern refinements have cast upon it. These three principles rightly viewed are general conceptions of the mind, as it endeavours to class the various objects of the sensible universe, and to refer the succession of events without itself to some ultimate unchanging views within itself. It has been already stated what is meant by a material cause, the ἐξ οὗ or ὕλη of Aristotle. These principles, then, are only different modifications of this cause. They are antecedents, or notions at which the mind ultimately arrives, in an analysis of its complex notions of natural objects; and therefore antecedents, because they must be presupposed in every contemplation of the natural world. The terms by which they are denoted are merely analogical. Aristotle, proceeding on a principle of the Pythagorean school,—indeed the common doctrine of philosophers before him,[2]—argues that, as contraries cannot generate contraries, there must be at least two opposite classes of principles. In the changes observed in the course of the world, one object is succeeded by another; something has passed away, something is produced. Two fundamental notions, therefore, are involved in every contemplation of nature. These accordingly are expressed by the terms *Form* and *Privation;* imperfectly characterizing these subtile abstractions, though justly, so far as the relation denoted corresponds with that between the present form of any material object and the previous forms superseded by it. For example, a statue is a form constituted in the stead of the rough block, and of that infinite multiplicity of figures of which the marble in its unmoulded state was susceptible. Of these it is, as it were, "deprived," in the act of producing the statue. The analogy, however, is apt to induce us to suppose that something positive is implied by the terms *Form* and *Privation* in the language of Aristotle. Hence the ridicule with which the statement of Privation as a physical principle has been received. But if rightly understood, it holds a just and important place in the physical philosophy of Aristotle. And to see the proper nature of it, it should be observed, that it applies no less to immaterial objects than to material.[3] For instance, if we look at man physically, we observe that he is capable of moral improvement. Supposing him, then, civilized and improved beyond his ordinary state, we perceive in such a case a transition from a state of barbarism to a state of culture. The state of culture, then, is the Form of which Aristotle speaks; the state of barbarism, which may be in infinite varieties of Form, the Privation. Or, a person becomes healthy from being diseased: health is the Form superinduced; the Privation is of every species of disease. But besides those principles which are excluded in the physical constitution of anything, and so referred to the head of Privation,—and those again in which the peculiar constitution of the thing is found to consist, and which are therefore referred to the head of Form,—there are evidently other principles which remain the same in all variations of Form. The internal nature of physical objects subsists under all external changes. The notion, therefore, by which that nature is represented to the mind, must be respected, in accounting for the physical constitution of a thing; as being an antecedent out of which it proceeded. To this notion, or class of principles, by which the one common nature of all physical objects is denoted, Aristotle applies the name of ὕλη, or matter: this notion being analogous to the stuff or substance of which different works of human art are constructed, as marble or brass is the material of which different statues are made[4].

Now, beyond *these* abstractions, it is impossible to proceed in the speculation on physical existence. They comprise, in fact, the whole of modern investigations in physics. Modern physical science has followed an order exactly the reverse of that of Aristotle. It has ended where he began. But it has had *these* several principles in view. The *abscissio infiniti*, prosecuted in the inductive method of philosophy, is analogous to the "privation" of the ancient system. It is a continued process of separating from any subject under examination, those natures or principles which do not constitute the proper nature of the subject, and thus gradually narrowing the inquiry more and more, until we have at last obtained some ultimate fact, expressing the proper nature of the thing. This ultimate fact, accordingly, Bacon terms the "form" of the thing, adopting the received language, whilst varying its sense to denote the ~~law or~~ principle by which it exists. It is the ~~result which~~ remains to be affirmed, after rejecting and excluding other principles; or, in other words, after the subject has been "deprived" of all those "forms" in which its proper nature does not consist. Again, Bacon directs that a collection be made of all those "*instantiæ,*" instances to which the form in question seems to belong. These instances, so far as they agree in this respect, correspond with the Material principle of Aristotle. They exhibit that common nature, in some one form of which the particular nature sought must be found.

It is not meant here that Aristotle conceived of these principles according to this view of them. The design of his inquiry is, by an analysis of Nature, to obtain those fundamental notions to which all the various notions involved in the speculation of Nature might be referred. For he explains things that have their being by Nature, to be such as have *in themselves* a principle of motion and rest,

[1] *De Cœlo*, i. 12, p. 449, Du Val. Also *Metaph.* xiii. 5; and v. c. 12.

[2] *Nat. Ausc.* i. 6, p. 322, Du Val.

[3] *Metaph.* vii. 7, and 11; xiv. c. 8; ὅσα ἀριθμῷ πολλα, ὕλην ἐχει, p. 1003, Du Val.

[4] *Nat. Ausc.* i. 8, Ἡ δε ὑποκειμενη φυσις, επιστητη κατα αναλογιαν· ὡς γαρ προς ανδριαντα χαλκος, η προς κλινην ξυλον, η προς το αλλο τι των εχοντων μορφην, ἡ ὑλη και το αμορφον εχει, πριν λαβειν την μορφην· ὅτως αὕτη προς ουσιαν εχει, και το τοδε τι, και το ον.

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as contrasted with works of art, the principle of which is in the artist.[1] Aristotle's object, accordingly, is to examine this inherent principle of motion and rest, which is the nature of a thing, and to shew how it operates in producing the various forms observed in the world around us. His error was not unlike that of one who should profess to give an account of visible objects solely from what they *appear* to the eye, and who should accordingly describe such objects as flat surfaces, variously shaded and coloured. From this view of the object of natural philosophy, he was led to account for the processes of generation and corruption, and the changes which occur in bodies by alteration, increase and decrease, local motion, mixture. Consequently, he states the great principles of Matter, Form, and Privation, as generalizations of those latent processes by which physical effects are produced, rather than as principles by which the investigation of nature must be guided. Hence the perverse application of his physical philosophy in the middle ages to work transmutations in nature. The labours of the alchemists were nothing else but a practical realism founded on the speculative principles of the philosopher.[2]

The discovery of the principle to which the denomination of Form is assigned, is, in Aristotle's system, as in Bacon's, the ultimate point of physical inquiry. The investigation of the principles of Matter and Privation is in order to the discovery of the Form; which is thus the τελος, the end, or completion of the process of nature. The principle of self motion, or instinctive tendency, which, according to Aristotle, is the proper object of physics, is then traced to its effect on the thing produced, and we have obtained the *ουσια*[3] or proper being of the thing.

From this view of the principle of Form, as the result of a self-working power in Nature, results the peculiar character of Aristotle's physical philosophy. He thought it evident, from such facts as the provident care shewn by spiders, ants, and other animals, and the service of the leaves of plants in protecting the fruit, that nature intrinsically possessed this power of working certain ends.[4] The form, then, of every physical object being the attainment of such an end, and the form also constituting the being or nature of the object, occasion was furnished for speculating *a priori* from the supposed perfection, or view of what was best, in anything, to the form or law in which its nature consisted. This mode of speculation was embodied in those maxims of ancient philosophy, that "nature does nothing in vain;" that "nature always works the best that the case admits;" that "nothing by nature is imperfect."[5] The consequence was, that the very point to be ultimately investigated was assumed at the outset of the inquiry, and the conclusions accordingly were only hypothetically and not absolutely true. And thus it is that Aristotle expressly admits the necessity which belongs to physical truths to be hypothetical—dependent, that is, on the assumption of the end pursued by nature, in like manner as the conclusions in mathematics are dependent on the assumption of definitions.[6]

It is curious to observe the traces of such a doctrine in different systems of philosophy, as they appear under different modifications. In some of the older theories, we find indications of it in the hypothesis of two opposing principles, as love and enmity, by which it was proposed to solve those appearances in nature which were adverse to the notion of the tendency of Nature to the best. In the systems of Parmenides and Hesiod, love and desire—in that of Anaxagoras, intellect—were the expressions of this tendency. In the philosophy of Plato, it was evidenced in the rejection of the material world from the class of permanent and real existences; this doctrine being a ready transition from the notion which attributed the physical constitution of things to their dependence on some primary ideal principles. Modern deists have argued in the same way, when they have rejected a Revelation because the things contained in it did not correspond with what they had determined to be "best" in nature.[7] In Aristotle, on the contrary, it was shewn in the theory of the Eternity of the Universe. For if Nature is an active principle, ever tending to realize in act the perfect form of everything, the existence of the universe at all times is necessary as a condition in order to this end.

The great doctrine of the ancient physics, that "nothing could be produced out of nothing,"[8] required no distinct consideration according to the theory of Aristotle. Inquiring into nature simply as a principle of motion, he was only called upon to shew how those changes which took place in the material world might be accounted for. It was no part of his philosophy to demonstrate that any particular element, or combination of elements, was employed in the laboratory of nature for effecting the various productions and transmutations. All he assumes is, that some material or other is employed in every instance, to effect that perfect constitution of it in which its "form" consists. An object, indeed, is not a physical object, unless it is conceived in conjunction with "matter." If only it has "matter,"—that is, a nature capable of affecting the external senses,—what particular kind of matter it may have, is irrelevant to his inquiry.[9] For example, whether water or air must pre-exist in the production of the other of these two elements, is not the point with which he is concerned. It is enough that there is in every physical effect a principle of motion operating. It follows, from the existence of such a principle, that there must be also "matter;" otherwise the *material* effect—the effect cognizable by the senses—would not have been produced.

The analogous inquiry in his system is, what principles are *prior* in the order of transition, so that from their presence or absence the constitution of any particular body results? What are those, in any instance, which never pass into each other, and of which a physical object cannot be deprived without its destruction; and which may therefore be regarded as elementary principles.

Hence his detailed investigation of Motion, in the technical sense in which the term is employed in his philosophy. In his system, changes of place or quantity or quality, generation and corruption, the action and passion of bodies, their mixture, are all instances of Motion. Hence also his discussion in his physics of questions which, in modern philosophy, are more properly regarded as the province of the metaphysician; as the nature of infinity, of time, and place, &c.: all which subjects, however, belong to his inquiry,

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[1] *Nat. Ausc.* ii. c. 1, ὡς ουσης φυσεως αρχης τινος και αιτιας του κινεισθαι και ηρεμειν, εν ᾧ ὑπαρχει πρωτως καθ' αὑτο, και μη κατα συμβεβηκος. *Metaph.* xiii. c. 1, δια το περι τα εχοντα εν αὑτοις αρχην κινησεως και στασεως την του φυσικȣ πασαν ειναι πραγματειαν. Also *De Cœlo*, i. c. 2.

[2] The doctrine of transubstantiation is wholly built on, and maintained by, a logical philosophy of this kind. The remark will readily be extended to other refinements of scholastic theology.

[3] Hence, he observes, the term *nature* is metaphorically applied to denote the being, *ουσια*, of anything. (*Metaph.* v. c. 4.)

[4] *Nat. Ausc.* ii. c. 8, Μαλιστα δε φανερον επι των ζωων κ. τ. λ. *De Anim.* iii. c. 12, Ἑνεκα του γαρ ἁπαντα ὑπαρχει τη φυσει, η συμπτωματα εσται των ἑνεκα του. *Polit.* i. 1, οἱον γαρ ἑκαστον εστι, της γενεσεως τελεσθεισης, ταυτην φαμεν την φυσιν ειναι ἑκαστου, ὡσπερ ανθρωπου, ἱππου, οικιας.

[5] *De Anim.* iii. cap. 10 and 12; *De Cœlo*, i. cap. 4, and ii. cap. 5, 8, 11; *De Gen. et Cor.* ii. c. 10; *Polit.* i cap. 1, 5.

[6] *Nat. Ausc.* ii. cap. 9.

[7] See Bishop Butler's *Analogy*, Introd. p. 9; also *Origen. con. Cels.* ii. p. 102, ed. Cantab.

[8] *Metaph.* xiii. cap. 6, Το γαρ μηδεν εκ μη οντος γενεσθαι παν δ' εξ οντος, σχεδον ἁπαντων εστι κοινον δογμα των περι φυσεως. Also *Nat. Ausc.* i. cap. 5.

[9] *De Gen. et Cor.* i. cap. 3, Τὸ δη ταυτα, η τοιαυτα ἑτερα ὑποτιθεσθαι, διαφερει ουδεν· τον γαρ τροπον ζητουμεν, αλλ' ου το ὑποκειμενον.

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inasmuch as they are implied in the various processes of Motion.

A speculative difficulty, however, occurred in the prosecution of this physical theory, like that which perplexed the material philosophers in respect to the pre-existence of matter. He had to account for the production by Motion of "a Form" not previously existing.[1] This he explained by the subtile distinction between potential and actual being. This, in fact, is his analysis of Motion; Motion being the exertion in act of that intrinsic efficacy which is in a thing to produce a particular Form. He speaks of this power in Nature of working ends, as analogous to the skill of a physician[2] working his own cure. Nature, which is thus in his view as a kind of life[3] to all existing things, realizes in itself those principles, which are inherent in its constitution, before latent but now developed, when an actual effect takes place. Nothing, accordingly, is produced, in his system, which was not, though in another mode, before in existence. What already existed potentially is produced into actuality and manifested to our perception in some physical object.[4] To describe it in terms of modern philosophy, we should say it was a transition from metaphysical existence to physical; from the subjective to the objective; from an object of the mind only cognizable by the internal principles of our constitution, to an object of the external senses;—the mind perceiving the principle of motion *as a principle,*—the senses giving us the impression of the principle *moving* or operating on matter.

This doctrine of potential being, transmitted by the speculations of the schools, and perverted to realism, has given occasion to represent a coincidence on this point in the system of Aristotle with the ideal theory of Plato, the very part of Plato's philosophy which Aristotle most directly opposed. But it should be observed, that the forms of which Aristotle speaks are not, like the ideas of Plato, separate existences, constituent of physical objects. They are the philosophy of nature considered as an instinctive principle of motion—general principles under which the mind classes the effects of physical power, analogously to its own operations when it proceeds to realize in some outward act any idea which it has conceived.

Leaving, then, the question as to the element or material itself, of which physical objects are composed, untouched, Aristotle examines what principles reject and exclude one another in the various changes of the material world. For these are the causes of the transitions of one nature into another, and of generation and corruption: the presence of one involving the privation of all those forms of matter dependent on the presence of the other. What these mutually excluding principles are, he decides by a reference to the sense of touch; that being the proper evidence to us of the existence of body. Sight, indeed, may give us the first notices of the *existence* of a material thing; but it does not inform us of the *material* nature of the thing. This we infer from the resistance to the sense of touch. Accordingly, Aristotle explains what is sensible to be what is tangible.[5] The contrarieties then ascertained by touch, and which account therefore for all the different forms of matter, are hot and cold, dry and moist; the first two as active principles, the last two as passive. The touch, indeed, informs us of other contrarieties, but they are all reducible to these four heads, with the exception of light and heavy. The last are excluded from the class of physical principles. For though, in common with other ancient philosophers, he held them to be positive and absolute natures, he found, that they could not act on each other, and therefore could not effect any physical change. As hot and cold cannot co-exist, nor can moist and dry, these four principles admit only of four combinations: and the effect of each combination is a different element. The combination of hot and dry, is fire; of hot and moist, air; of cold and dry, earth; of cold and moist, water. Any one of these element may pass into another[6] by the privation of one of the combined principles. In such an event, the contrary principle, which had been only excluded by the presence of its contrary, combines with the remaining one. For example, water is transformed into air, by the privation of cold, and the consequent combination of hot with the moist which remains. Or both principles combined may be superseded by the two opposites, as when fire and water may be changed into each other. Thus there is a subordination of principles wherever the principle of motion is exerted in act. First, there must be matter, that is, a principle susceptible of the contrarieties; then the contrarieties; and last of all, the material elements themselves.[7] When the change effected involves an entire change of the material from which it proceeds, the process is that of generation and corruption. But when the change is simply in the affections of some existing body, as in the instance of a person from being unmusical becoming musical, or of the food of an animal being converted into its substance, the process is that of alteration.[8]

Thus does Aristotle account for all the changes which take place in the world immediately about us. Whether we observe things generated, or altered in their sensible qualities, or varied in bulk, or place (and to one or another of these every physical effect may be referred), the changes observed may be traced to the operation of a principle which is either one of these four already mentioned, or some modification of them. For all the intermediate principles between two contrarieties, or the degrees of them, are to be regarded as contrary, and capable therefore of effecting physical changes in the same manner as the extremes.

But the changes which occur immediately in the world around us, constituted, in the view of the ancient philosopher, a very inferior part of the objects of physical science. The luminaries of the superior celestial world were regarded by Aristotle as more excellent than man, and the study of their laws as a higher employment of the intellect than the philosophy of human life.[9] Besides, however, the intrinsic excellence of this branch of physics, it demanded his attention from its necessary connection with the development of his theory of Motion. Now, all other physical changes imply local change. Local change may therefore be inferred to be prior to every other.[10] Further, to keep up the constant succession of generation and corruption which is carried on in the world, and the passing of one nature into another, there must be some principle ever in *actual* being. But, no other than the revolution of the heavenly bodies continuing incessantly, this alone exhibits a principle of local motion adequate to the effect. Aristotle, accordingly, was led to speculate on the motions of the heavens, in order to trace up the propagation of Motion in this lower world, through its successive impulses, to the First Mover. This being discovered, his philosophy of Nature is completed: since Nature is then fully explored according to his analysis, as the principle of motion and rest.

His whole astronomy is deduced from the notions of lightness and heaviness, as intrinsic and absolute properties of

1 *Nat. Ausc.* iii.; *De Gen. et Cor.* i. cap. 3.
2 *Nat. Ausc.* ii. cap. 8, Μαλιστα δε δηλον, όταν τις ιατρευῃ αυτος ἑαυτον· τουτῳ γαρ εοικεν ἡ φυσις.
3 *Ibid.* viii. cap. 1, Οἱον ζωη τις ουσα τοις φυσει συνεστωσι πασιν.
4 *Ibid.* viii. cap. 14. Du Val, vol. i. p. 414.
5 *De Gen. et Cor.* ii. c. 2.
6 *Ibid.* ii. c. 4.
7 *Ibid.* ii. c. 1, ἡμεις δε φαμεν ὑλην τινα των σωματων των αισθητων, αλλα ταυτην ου χωριστην, αλλ᾽ αει μετ᾽ εναντιωσεως, κ. τ. λ.
8 *Ibid.* i. c. 4.
9 *Eth. Nic.* vi. c. 7.
10 *Metaph.* iii. c. 2, p. 8υ0; *Mag. Mor.* i. c. 33.

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bodies. He considers lightness the same as positive tendency upwards, and heaviness as positive tendency downwards. But this view implied that there were certain fixed points, the extremes to which these qualities of bodies tended, and in which bodies naturally rested as they possessed either lightness or heaviness. Each of the material elements, accordingly, had its proper place in the universe, corresponding to the degree of lightness or heavinesss which he conceived them to possess, both absolutely in themselves, and relatively to each other. Fire he placed in the extreme point upwards, earth in the lowest; air next to fire, and water next to earth. Each of these elements, therefore, he argued, as naturally tending either upwards or downwards, moved in a straight line, and could not consequently move *naturally* in a circle. Hence the earth must be at rest, and therefore be the centre of the universe. For if it revolved round the sun, as the Pythagoreans thought, it would be moving unnaturally, and therefore could not move eternally. Hence, also, no revolving body could consist of any of the four material elements. It must be some other material, some other element, to which circular motion was as natural as rectilineal motion is to earth or fire.

On the ground of such speculative notions Aristotle proceeded in constructing his system of the universe; in opposition to the more enlightened conclusions of the Pythagorean, and the records of Egyptian and Babylonian[1] observations on the heavens. In some instances, indeed, his view was more correct. He admits the spherical[2] form of the earth, from the evidence of lunar eclipses, in which he had remarked that it always exhibits a curved outline; and infers its magnitude to be not very great,[3] from the variation of horizon consequent on a little variation of our position on its surface. But, in acknowledging these facts he was influenced by their accordance with his speculations *a priori*, as he rejected or misinterpreted other facts from their repugnance to these speculations. For the spherical form of the earth resulted from his theory of heaviness. It was the effect of the tendency of all the particles of the earth to the lowest point; this lowest point being a centre of the two opposite hemispheres of the heavens. For, that the whole heavens were spherical, he supposed a necessary consequence of the perfection belonging to them, a solid being the perfect mathematical dimension. The tendency, consequently, of all the particles of the earth to the lowest point, was a tendency towards a middle; or this lowest point would be a centre round which the earth would adjust itself in a spherical mass.

The reason assigned by Aristotle for the revolutions of the heavens, as appears, then, is precisely opposite to that of modern philosophy. He conceived revolution to be performed, not in consequence of a tendency to the centre, but of the absence of any such tendency in the revolving body. Revolution and gravity are, according to him, contradictory terms. The motions of the several heavenly bodies result from their being carried round by spheres, which consist of this revolving element. That they do not revolve in themselves he considers to be evident from the fact that the moon always presents the same side towards us. They are incapable indeed of motion in themselves, he argues, in being spherical, nature seeming purposely to have denied them all power of motion in giving them the form least apt for motion. They revolve, therefore, from being bound in revolving spheres, the first in order of which is that in which the fixed stars are placed, and then the several planets (five in number), the sun, and next to the earth the moon;[4] and to account for the apparent irregularities in the motions of the heavenly bodies, he supposes, following the theory of Eudoxus,[5] that there were as many additional spheres employed in the revolutions of each body as it appeared to have different motions.

The oblique motion of the sun, viewed in connection with the successive renewals and decays of nature, as he approaches or recedes from the earth, suggested the most ready link for connecting the phenomena of the earth with those of the heavens. It is, accordingly, to the revolution of the sphere of the sun, that Aristotle ascribes the continuation of generation and corruption in unbroken series, and the consequent perpetuity of being in the world around us. It might be supposed that generation and corruption would be carried on at equal intervals. But the unequal temperament of material things prevents such a uniformity; and occasions that variety of duration, which we observe in different things within the sphere of the moon, the sublunary world, or the limits of Nature properly so called.[6]

Still, however, it remained to be explained what it was that imparted to the sphere of the sun, as well as to the several other spheres, their principle of motion. To every thing that is itself moved there must be a mover: and the successive motions, therefore, as communicated from sphere to sphere, must be traced up to some first principle, itself unmoved, in which they originate.

Here, then, we discern the close connection of Aristotle's Physics with his Metaphysics; and at the same time the ground of his applying to the latter science the designation of Theology. The several spheres of the heavens, differing in element from the bodies of this lower world, and pursuing their unceasing and immortal revolutions, presented a distinct class of ουσιαι, beings, or substances, to the speculation of the philosopher. To ascertain that in which they moved and had their being, was an inquiry, with regard to them, analogous to his investigation of the principle of Motion in the natural world. This principle of motion to these celestial substances would be Being itself, or the very vital Energy in which they had their being.[7] At the same time, in exploring this primary Being, he would be tracing those general principles by which the mind held together the various objects of physical contemplation to one primary law or master-principle, in which, as in a single theorem, all the truths of philosophy should be comprized.[8]

This intimate connection of Theology with Metaphysics, in the Ancient Philosophy, was a natural consequence of the separation which heathenism established between Theology and Religion. In the civilized states of antiquity, Religion was pursued only as a matter of policy, and not as a rule of

[1] *Metaph.* i. 1. Herodot. *Euterp.* 109.

[2] He speaks of it in *Meteor.* ii. c. 5, p. 562, as shaped like a tympanum.

[3] Mathematicians, he says, had computed its circumference to be 400,000 stades, or about 40,000 miles.

[4] The Pythagoreans connected with this notion the beautiful fancy of the music of the spheres. Aristotle expresses his admiration of the thought, but denies its possibility. The stars move with the spheres, he says, like the parts of a ship with the ship, and therefore can make no sound. (*De Cœlo*, ii. 9.)

[5] *Metaph.* xiv. c. 8. Eudoxus assigned fifty-five spheres on the whole; or, deducting those added to the sun and moon, forty-seven. Aristotle only states this as what may reasonably be thought; leaving, he says, the assertion of its necessity to others more positive, *ισχυροτεροις*, than himself, p. 1003, Du Val. Eudoxus of Cnidus went into Egypt about 368 B.C. and introduced the regular astronomy from Egypt into Greece. Aristotle gives him the high praise of recommending his theory of Pleasure as the Chief Good, by the distinguished morality of his life. (*Eth. Nic.* x. 2.)

[6] *De Gen. et Cor.* ii. c. 10.

[7] *Nat. Ausc.* viii. c. 4, 5, 6, 8; *Metaph.* xiv. c. 6 and 7.

[8] *Metaph.* iii. 2, *ἡ μεν γαρ αρχικωτατη, και ἡγεμονικωτατη, και ἡ ὡσπερ δουλας ουδ᾽ ἀντειπειν τας αλλας επιστημας δικαιον, ἡ του τελους και τἀγαθου τοιαυτη.*

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life to the individual. Whatever was the established creed of the state, it was the recognized duty of the good citizen to support as established.[1] Not involving any question of truth or falsehood in the particular creed adopted, it readily admitted of any additions of superstition not repugnant to the laws and manners of the state; but imperiously rejected all questioning of the fundamental assumption of the importance of that which was established.[2] It may be said to have been the great principle of their religion, that it should be made no question of truth and falsehood. The religious instincts of the human heart were under such a system at once gratified and diverted from their proper end. Their strength was spent in the vain amusement of festal ceremonies, and their purity corrupted by demoralizing orgies. In this state of things, the better and wiser part of men were driven into a metaphysical religion. They could not acquiesce in the views of the Deity presented by the popular superstitions. Yet the subject could not but recur to them in the reasonings of their hearts, as soliciting earnest inquiry. They searched for God, accordingly, not seeking what to *do*, but what to *know*. Whatever the truth concerning Him might be, it was not to be expressed in the uplifting of pure hearts and hands to Him. Though the whole world might be found his temple, He was not to be worshipped as the Holiness of their shrines. Though the heavens were telling of his glory, and the stars were singing together for joy at his presence, yet no praise was to ascend to Him, the Lord of heaven and earth, in the perfumes of their altars, or the poetry of their hymns. Thus devotion, being banished from the heart, sought a refuge for itself in the wilderness of a speculative theological philosophy. Hence Socrates and Plato, and Aristotle and Cicero, and other illuminated sages of heathenism, continued, without hypocrisy, professors of the established religion, whilst they aspired after a purer knowledge of God in the thoughtful abstractions of their own intellect.

Looking, then, at the admirable order of the heavenly bodies, the philosopher saw, in their unvarying regularity, the immutable and eternal nature of the great Principle on which their motions depended. He did not, it seems, attribute to them a proper divinity in themselves; for he refers their perpetuity of motion to the ultimate principle or First Mover, the Deity of his system. But he speaks as if they possessed a divine nature.[3] He also says that we must think of them as partaking of life and action. He must be supposed, however, by such expressions, to be giving only an analogical description of the perfection in which they display the efficacy of the First Great Principle. Contrasted with the unstable things of the earth, they evidence the Principle of Motion perpetually operating without interruption; whereas the successions of generations and corruptions about the earth only approximate to the perpetuity of the heavenly motions. We ought indeed to interpret in the same manner his ascription of power to Nature as a Principle of Motion. It seems as if he was excluding the agency of Deity. But in truth he is only tracing the mode of the operation of the First Principle. For he thinks that all things attain the good of their nature, so far as they have something *divine* actuating them. It is this divinity in them which is the primary source of all perceptions of pleasure.[4] Further, it is the indistinct apprehension of the same that he supposes to be the motive of exertion in all things that are capable of action, though they may be unconscious of its being so.[5] Hence it has been maintained, that the doctrine of Aristotle differed but little from the pantheism of the modern infidel.[6] The operations of Nature, then, as well as the revolving spheres of the heavens, are divine, inasmuch as they illustrate more or less perfectly the animating principle of all Motion,—the operation of Deity itself. At the same time, there is no notion of Deity inculcated under the idea of the Creator and Governor of the Universe. It is simply as the Life of the Universe—the Intellect—the Energy—as what gives excellence, and perfection, and joy to the whole system—that his philosophy sets forth the notion of Deity. It is, in short, pure Being, abstracted from all matter, and therefore only negatively defined as without parts or magnitude, impassible, invariable, eternal. But whilst his system included no providence,[7] it has the merit of excluding the operation of chance and accident. These, he observes, are not capable of being causes of any thing; they are merely descriptions of what takes place contrary to some presupposed design, or some tendency in Nature.[8]

In his Metaphysics, properly so called, he considers this First Principle strictly in a metaphysical point of view. His professed object here is, to inquire into "Being so far forth as it is Being, and the general properties belonging to it as such."[9] Having traced the changes which occur about the earth to a fixed principle, he had presented one unchangeable point of view in which the human mind might contemplate the vast and restless variety of physical objects. It remained for him, then, to examine this principle in itself, in order to attain a sure and perfect science, the highest and first Philosophy, in the knowledge of the fixed and immutable, and necessary.

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[1] See Xenophon's *Memorab.* iv. c. 4. The great rule of piety inculcated by Socrates is, Νομῳ πολεως. See also Polyb. vi. 56.

[2] Even Aristotle says that there are some who are not to be argued with; and mentioning such as require punishment rather than argument, he instances in those who question "whether one ought to honour the gods, or love parents," *Top.* i. See also *Eudem.* i. c. 3.

[3] *Metaph.* xiv. 8. p. 1003, "It has been handed down by the primitive and ancient, left to those after them in the figure of fable, both that these are Gods, and that the Divinity encompasses universal nature. But all else has been fabulously associated for influence with the multitude, and for its use in respect to the laws and expediency. For they say that these are of human form, and like some of the other living beings; and other things, they say, consequent on, and similar to those mentioned. From which accounts should one separate and take that only which was first, that they conceived the first Beings to be Gods, he might consider it to have been divinely said; and that, as probably each art and philosophy has been often discovered to the utmost and again lost, so also that these their opinions, like relics, have survived up to the present time. Now our hereditary opinion, and that derived from the first men, so far only is manifest to us."

[4] *Eth. Nic.* vii. c. 13, παντα γαρ φυσει εχει τι θειον, κ. τ. λ.

[5] *Ibid.* x. 3, ισως δε και εν τοις φαυλοις, κ. τ. λ.; also, *Metaph.* xiv. 7, p. 1000, Du Val; *Polit.* vii. 3, σχολη γαρ αν ὁ θεος εχοι καλως, και πας ὁ κοσμος, κ. τ. λ.; also *De Cœlo*, i. 9. In *De Anim.* i. 3, he substitutes "the Deity," where, according to his usual mode of speaking, he would say "nature," καιτοι γ᾽ εχρην τον θεον, κ. τ. λ. p. 625, Du Val.

[6] See Bayle's *Dict.*, article Aristotle.

[7] There is a passage in his *Ethic. Nicom.* x. 8, in which he alludes to the supposition of a divine superintendence, επιμελεια; but he there evidently makes the appeal rhetorically, to recommend that cultivation of the intellect in which he places man's highest happiness. A further evidence of this is, his speaking of *gods* in the plural in that passage. At any rate, the superintendence here spoken of is distinct from what we mean by providence, as he does not suppose it extended over the bad as well as the good. In his *Magna Moralia*, ii. c. 8 (Du Val, vol. ii. p. 185), he argues that the superintendence and benevolence of the Deity cannot be supposed the same as good fortune, ευτυχια, because it is not reasonable that the Deity should superintend, επιμελεισθαι, over the bad; and that we observe the bad sometimes fortunate.

[8] This view of Chance agrees with the remark in Thucydides, that "we are accustomed to charge Fortune with whatever happens παρα λογον, out of, or beside, the course of reason," book i. chap. 140. Aristotle has expressed the same in his *Rhetoric*, i. c. 5, εστι δε και των παρα λογον αγαθων αιτια τυχη.

[9] *Nat. Ausc.* ii. 6, 7, 8; *Metaph.* xiii. 8.

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This employment of the term "Being" may give the appearance of the investigation being concerned with positive objective realities, independent of the human mind for their existence. But though his mode of expression, and perhaps his example in some parts of his Metaphysics, may have afforded occasion to the ontology of the schools, he cannot justly be charged with the realism and absurdity of that system. These may be traced chiefly to a circumstance already adverted to—the introduction of Aristotle's philosophy into the Western Church by the medium of Latin translation. The term *ουσια*, by which he denotes existence in the abstract, as distinct from any object of which it is affirmed, having been rendered in Latin by *substantia*, it came to be supposed that the natures or principles represented by the term had a real subsistence. Thus the doctrine of Aristotle respecting Being was understood in a sense precisely the reverse of that which the philosopher himself intended. The analogy on which the application of the term *substantia* to metaphysical subjects was founded, became obscured by the actual force of the term itself. Instead of its being regarded as denoting only a relation between our conceptions corresponding to that between a thing supported and what supports it, the idea was suggested of an external objective reality, or even of a material nature, as implied by the term.

Rightly, however, to understand Aristotle's notion of Being, as it is the object of his Metaphysics, we should distinguish between Being as it is in nature generally, and as it is conceived in the human mind. For it is in this last sense that it must be understood, when it is stated to be the *object* of the universal science; since there is no other sense in which Being which is not in anything can be affirmed, but as it is the pure object of intellect, or exists in the intellect solely. Looking, then, at nature at large, we must apply Being, in its first and proper sense, to individual objects really existing; and, in a secondary sense, to the attributes of such: because, the first notion of Being in nature is suggested by the actual existence of the object; and our next notions result from the operations of our minds about the object already presupposed in existence. But the case is different when the objects whose being we are considering are pure objects of intellect in themselves. Here the abstract notions of things are the first in order:[1] these are, relatively to the mind, the realities about which it is engaged; whereas the actual objects in nature are, in this point of view, the secondary beings. The reason is, that an object of the mind, as such, exists in its proper nature when it is entirely abstracted from all matter, but loses that nature in proportion as it is viewed in any actual form of physical existence.

Hence, in the science of Metaphysics, the proper if not the only substance, or *ουσια*, is the form or abstract nature of things.[2] This, as explained by Aristotle, is the exemplar or representation in the mind of a thing as it exists in nature. As, then, the primary substances in nature are the things themselves as they are found and observed in nature, so the primary substances in the world of the mind are those abstract forms by which the truth and reality of things are there shadowed out. The science of Metaphysics, then, is strictly conversant about these abstract intellectual forms, just as Natural philosophy is conversant about external objects of which the senses give us information.

The object, then, of Aristotle in his Metaphysics is, to explain the nature of those general notions by which the mind represents to itself, and translates, as it were, into its own language, the objects without it, and speculates about them. Hence, in technical terms, he speaks of this science as the science of First Causes—the First Philosophy—or by the general titles of Philosophy and Theology. A science such as this, corresponds with what modern writers have designated the Philosophy of the Human Mind. They, indeed, have directed their attention rather to the powers and operations of the Mind; the study of which, in his view, belongs to Physics. He, however, has confined himself—in those books at least which, as a sequel to the Physical, have obtained, from that circumstance, the name of the Metaphysical—to the objects about which the Mind is immediately conversant.[3]

In this inquiry, Aristotle had to encounter two extremes of opinion maintained by philosophers before him—the doctrine of Protagoras, Empedocles, and others, who held that there was no fixed standard of thought—no absolute reality,—but that everything was relative to human perception; and the imaginative theory of Plato, which, by the hypothesis of self-existent Ideas, introduced a subtile materialism into the philosophy of mind, whilst, no less than the former theory, it made the external world a land of shadows and unrealities.

He points out the practical absurdity of the former opinion, according to which contradictories were equally true, and every proposition was equally true and equally false—by asking,[4] "why a man walks to Megara, and does not remain still, thinking that he is walking; why he does not go down a well or a precipice, as it may happen, the first thing in the morning, but appears to use caution, as not equally thinking the falling in to be good, and not good?"[5] Again, that men do not regard all notions as equally true, is plain, he observes, from this, that "no one who may have supposed himself during the night at Athens, when in Libya, walks to the Odeum."[6] He refutes, however, this sceptical doctrine more expressly, by distinguising between the reality of things as they exist absolutely or relatively to our perceptions. There may be no reality of Being, either in that which is perceived, or in the perception, these being affections of the percipient power. But it is impossible, that there should not really exist some objects externally, which produce the perception, and are independent of perception. Whereas those who make *Being* dependent on perception, by asserting that whatever appears is true, imply that nothing would exist if there were no living creatures.[7] Hence it appears that Aristotle virtually admits the distinction made by modern metaphysicians between the primary and secondary qualities of matter. He affirms, that whilst we have ideas of things without us which are simply our own perceptions, or acts of the perceiving mind, there must also be some really existing natures without us on which these perceptions are founded.

The Ideal theory of Plato tended to the same scepticism as the doctrine of these elder philosophers, but on a different principle. Plato destroyed all the certainty of our knowledge, by fixing the objects of it entirely out of the range of human intellect, and teaching men to abandon the information of the senses and experience, in the pursuit of abstract Ideas, the imaginary archetypes or exemplars of the things of the sensible world. He established in his system other beings separate from nature as the objects of philosophy; whilst his predecessors denied that there were any proper objects founded in nature. But both he and they equally removed all grounds of conviction from the mind of man. Aristotle, accordingly, strenuously combats the doctrine of Ideas as adverse to all sound speculation. He loses no opportunity, in the course of his discussions, of alluding to it and refut-

[1] *Metaph.* xiii. c. 4, την δε πρωτην ειρηκαμεν επιστημην τουτων ειναι, καθ' όσον οντα τα ὑποκειμενα εστιν, αλλ' ουχ ῆ ἑτερον τι.

[2] *Ibid.* vii. 5.

[3] Τὰ μέτὰ τὰ φυσικὰ.

[4] *Ibid.* iv. c. 4; Du Val, ii. p. 876.

[5] *Ibid.* iv. c. 5.

[6] *Ibid.* iv. 4, 5.

[7] *Ibid.* iv. 5, το μεν ουν μητε τα αισθητα ειναι, μητε τα αισθηματα, ισως αληθες· του γαρ αισθανομενου παθος τουτο εστι· το δε τα ὑποκειμενα μη ειναι ἁ ποιει την αισθησιν, και ανευ αισθησεως, αδυνατον.

Theoretic Philosophy.

ing it.[1] He speaks of it as overthrowing all science, by multiplying, instead of reducing to certain definite principles, the variety of the objects of contemplation. "It is like," he says, "any one wishing to reckon, but who, thinking himself unable when he had less, should make more, and then reckon."[2]

The Ideal theory was, as has been before remarked, a modification of the Pythagorean theory of Numbers, or a mixture of logical and mathematical truth. Hence the importance assigned by Plato to Mathematics, as introductory to the philosophy of the Ideas. The theory of Pythagoras was, it seems, purely mathematical. It appears to have been an application of the properties of numbers to the solution of the phenomena of the universe. Plato proceeded a step further, and endeavoured more distinctly to account for the great variety of objects by the help of the abstractions of language. Still he retained so much of the mathematical conception as to make the knowledge of the Ideas dependent on the knowledge of mathematics; describing the objects of mathematics as intermediate to the Ideas and sensible objects.[3] Aristotle shews, then, in opposition both to the Pythagoreans and to Plato, that there are no such principles as Numbers or Ideas really existent in Nature as primary and constituent elements of things.

There is no point, in fact, on which Aristotle has spoken more plainly than in denying a separate existence to those secondary natures, which, in the language of the Schools, were afterwards called Universals. It is to individuals alone that he allows a real existence.[4] He remarks, that when any principle is asserted of several things, it is by analogy; as in fact there are distinct principles in each distinct thing; "for the particular is the principle of the particulars in each thing."[5] Thus, "whilst the universal man is the principle of man, Peleus is the father of Achilles—your own father of yourself." In things generically distinct, as colours and sounds, the principles differ, but are the same by analogy. In things specifically the same, the principles differ, not in species, but as they are distinct in each individual; *e. g.*, the matter, the form, and the moving power, are distinct in this and that man; but in the general principle, τῳ καθολου λογῳ, they are the same." So clearly has he laid it down, that none but individuals have a positive absolute existence, and that all other beings are relative to these, and results of the operation of our minds about them.

In extending our survey to the several subjects included in the metaphysical books, we must remember, that the science of which he is treating had hitherto been blended with logic under the general name of Dialectic. It was hardly to be expected, therefore, that Aristotle, in making the separation, should altogether forget the prejudice which had united them. Nor must we wonder, therefore, that much of the work should be employed in discussing the meaning of terms, and in observations addressed rather to the disputant in words, than to the inquirer into principles of philosophy. But we should be too hasty in judgment, if we condemned such discussions as foreign to the purpose of the metaphysician. The accurate examination of the notions expressed by such terms as being, oneness, sameness, contrariety, power, is illustrative of the connections of our ideas; for these terms are not dependent on the peculiarities of any one language, but are uniform characters of human thought. It is a curious and important inquiry, accordingly, to ascertain that connection of ideas of which these terms are the expressions; to trace, for example, the various modes of thought to which the term contrariety applies, or which are characterized under the description of qualities.

The inquiry, then, into Mind, considered in itself as a principle of life, and thought, and action, forms no part of Aristotle's Metaphysics. In his philosophy such an inquiry belongs to Physics; since he regards Mind only as a principle connected with matter. This inquiry he has prosecuted in a Treatise *On the Soul, or Life*, and in several smaller treatises *On the Parts and Motions of Animals*, *On Perception*, *On the Duration of Life*, *Youth and Old Age*, *Life and Death*, *Respiration*, *Memory*, *Sleep and Waking*, and *On Dreaming*. To these should be added the book *On Physiognomy*, and his larger work the *Treatise on Animals;* which, though properly a work of Natural history, is also illustrative of the nature of Soul, or the living principle in all animated, material beings. In these several works, there is less of mere speculation, and a more distinct evidence of that power of real philosophy, the δυναμις αναλυτικη, which he so eminently possessed. We find him stating and examining facts,[6] drawing from them conclusions in the spirit of a modern inquirer, though at the same time with the severe accuracy of his own method.

The ingenuity of the ancient philosophers was exhausted in attempting to assign the nature of the Soul or living principle. There was no one of the elements, except earth, which did not find its advocate in some theory of the Soul. It was represented also as a combination of all elements; or as blood; or intrinsic motion; or a harmony and conjunction of contraries. Aristotle, pursuing the method of his Physics, wisely avoids endeavouring to refer the soul to any particular class of material objects; explaining the nature of it, as it instances the union of the two principles, matter and form, in a common result. It is an instance of the principle of matter, so far as there must be an organized body susceptible of life in everything that lives. It is an instance of the principle of form, so far as that nature, in which the life of the creature consists, is perfectly developed in the animated body. His definition, accordingly, maintains the distinctness of body and soul[7] as two principles combined, without defining what the soul is in itself. He illustrates their union by the analogy of the eye and the sight.[8] There must be the eye in order to sight; but the eye, though perfect in its structure, is not an eye unless the principle of sight be superadded.

Thus, considering the principle of life as distinct from the organization with which it is connected, he proceeds to inquire into its laws, by examining the mode of its operation. He divides its mode of operation into five classes, according to the objects about which it is exercised. It is, 1*st*, a principle of nutrition, in which respect it is common to vegetables and animals; 2*dly*, of perception; 3*dly*, of appetites and affections; 4*thly*, of intellect; 5*thly*, of locomotion. Wherever there is perception, there are also, he states, appetites and affections;[9] and consequently all these modes of

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1 *Gen. et Cor.* ii. 9; *Analyt. Post.* i. 8, 19; *Eth. Nic.* i. c. 4; *Metaph.* xii. 4, 5; Atticus apud Euseb. *Præp. Evang.* xv. c. 13; Plutarch adv. *Colotem.*

2 *Metaph.* i. c. 7, and xi. c. 4.

3 See Plato *De Repub.* vii.; Aristot. *Metaph.* xii.

4 *Categ.* c. 5; *Metaph.* vii. c. 13; *Annal. Post.* i. 31.

5 *Metaph.* xiv. 4 and 5, αρχη γαρ το καθ' ἑκαστον των καθ' ἑκαστον.

6 He speaks of this part of his philosophy as an inquiry; την της ψυχης ἱστοριαν. *De Anim.* i. 1.

7 *De Anim.* ii. 2, και δια τουτο καλως ὑπολαμβανουσιν, οἱς δοκει μητε ανευ σωματος ειναι, μητε σωμα τι ψυχη· σωμα μεν γαρ ουκ εστι, σωματος δε τι, κ. τ. λ. p. 633, Du Val. Εντελεχειαν appellat novo nomine, quasi quandam continuatum motionem et perennem. (Cicero, *Tusc. Qu.* i.)

8 *De Anim.* ii. 1, ει γαρ ην ὁ οφθαλμος ζωον, ψυχη αν αυτῳ ην ἡ οψις, κ. τ. λ. p. 631.

9 *Ibid.* ii. 3, ᾡ δ' αισθησις ὑπαρχει, τουτῳ ἡδονη τε και λυπη, κ. τ. λ. p. 633. *De Animal. Motione*, c. 10, he compares the operation of the soul on the different parts of the body of animals, to a well-ordered state, in which the various offices are regularly administered without requiring the presence of the monarch on each occasion. (P. 709, Du Val.)

operation of the living principle are evidenced in brutes, with the exception of intellect, which belongs to man exclusively.

His observations on Perception are highly important, as tending to shew the existence of living powers in animals, distinct from the organs by which those powers are displayed. He affirms that there is always a medium interposed between the perceiving power and the object perceived,—appealing to the sense of sight. Sight, he observes, is not produced by placing the object on the eye, nor yet can be produced by the object itself at a distance. It must result, then, from something intervening between the eye and the object, so as to make an impression from the object on the eye. He mistakes, indeed, the nature of this medium, conceiving light to be the active development of the nature of transparency in some body, as in air or water,[1] and not material or capable of motion.[2] But the conclusion itself is just. And it serves to shew that the eye[3] perceives only as an instrument of communication with external objects to an internal power of the soul. The senses which appear to militate with this conclusion are those of touch and taste. For these seem to be produced immediately, without any interposed medium. But there is no reason, he argues, to conclude the flesh to be the feeling power in itself[4] because it acts instantaneously. For an artificial membrane spread over the body would produce the like instantaneous effect: and supposing the air to grow all around us, we should in like manner have immediate perception of all objects of sense, and thus appear to have perceptions of sight, and hearing, and smelling, by one sense.

Perception, then, according to Aristotle, is the power of the soul to receive immaterial impressions from material objects; as the wax receives impressions of a seal without the brass or gold of which the seal is made. The impressions thus received, he regards, as the basis of all our knowledge; insomuch that a creature destitute of perception would be incapable of understanding and learning. Touch[5] is the sense indispensable to existence, and the only one so indispensable. All the other senses, he says, have been added for the good and perfection of the animal—του ευ ἑνεκα. The sensations are distinct, however, from the ideas of the mind. The sensations in themselves are never delusive. The same thing is always sweet or always bitter. But the same sensations may be followed by different ideas in different minds. To a sick person, what is naturally sweet may seem bitter, or, from accidental position with respect to the spectator, an object may appear different from what it is; as, for example, the diameter of the sun. To the ideas thus formed immediately from Perception, Aristotle gives the name of phantasms; and the power of Perception thus modified he calls phantasia or Imagination.[6] The delusiveness sometimes attributed to the senses themselves originates in this faculty of Imagination consequent on sensation. Together with memory, it constitutes the whole intellectual nature of brutes. In man it furnishes the first notices in order to the operation of his intellect. By the operation of the intellect on these notices the first simple ideas are formed, from which the mind proceeds to its complex and general notions.

In considering the nature of the intellect, Aristotle introduces an important distinction between the mere capacity or faculty of knowledge, and the actual knowledge possessed by the mind; or between the intellect and the principles of the intellect. He employs the well-known illustration of "a writing tablet in which nothing is actually written," to distinguish the thinking faculty in itself from the thoughts with which it is furnished. But he does not suppose, as this illustration might suggest, that ideas are objects distinct from the mind itself. Where the object of thought is itself immaterial, as when the mind is reflecting on itself, there, he observes, the thinking power and the object of thought are the same.[7] He conceives, however, that the mind is capable of existing without thinking,[8] and consequently does not resolve the whole understanding of man into consciousness. Hence, according to him, whilst the passive intellect, or the mind, as it consists of principles with which the senses have furnished it, perishes, the active intellect, the power itself by which we think, exists in its proper nature when separate, and is immortal and eternal.[9]

It may be perceived, from this view of Aristotle's Theory of Soul, or Life, how far he acknowledged the Immortality of man. So far as the nature of man is purely intellectual, he conceived it capable of existing separately from matter, and in some sense divine. But so far as it consists of affections, which he describes as λογοι ενυλοι, principles *in* matter, he regarded it as mortal and necessarily perishable with the body. He pronounces nothing on the nature of that immortality which he thus attributes to the intellect, speaking of it in a rhetorical manner rather than with the precision of philosophy. At any rate, as only asserting an immortality of such an abstract and undefined nature, he seems not unjustly to have been represented as opposed to Plato on the doctrine of the Immortality of the soul.[10]

As Aristotle included under Physics animate as well as inanimate nature, he has carried the historical part of his natural philosophy into both these departments. His *History of Animals* has been already mentioned. It is the precious relic of an extensive work, for which the materials were furnished to him by the conquests and the magnificence of Alexander. This fact alone excites an interest in favour of the work. And this interest is fully sustained by the variety of curious information contained in it respecting the structure and the habits of animals, indicating a power of the most minute observation.[11] He is said also to have written a work on Comparative Anatomy. There are extant among his works further illustrations of the animal economy, in treatises on the motion, the walking, the parts, and the generation of animals. In inanimate nature he has explored the causes of meteors, comets, earthquakes, of the rainbow, and other phenomena of the atmosphere, in a work on Meteorology. He has also separately discussed the nature of Colours, and of the objects of Hearing.

To this catalogue must be added two works which do not strictly fall under either department of nature, *The Problems*, containing queries chiefly on subjects belonging to Natural Philosophy, with brief answers,—a curious work, illustrative of his vast reach of observation, and his extraordinary sagacity in searching out the reasons of things; and

[1] *De Anim.* ii. c. 7, ἡ δε εντελεχεια του διαφανους φως εστι, p. 369. *De Sensu et Sensil.* c. 2.

[2] *De Anim.* ii. c. 7.

[3] The eye, he says afterwards, sees only, η διαφανες, so far forth as it is transparent, no otherwise than water or air. (*De Sens. et Sensil.* p. 664, Du Val.)

[4] *De Anim.* ii. c. 11. p. 644.

[5] He considers natural talent as connected with the delicacy of this sense. (*De Anim.* ii. c. 9, p. 642.)

[6] *Ibid.* iii. c. 3 and 4; *Metaph.* iv. c. 5. The term *imagination* must here be understood in the most general sense.

[7] *Ibid.* iii. c. 5, επι μεν γαρ των ανευ ὑλης το αυτο εστι το νοουν και το νοουμενον, p. 653.

[8] *Ibid.* του δε μη αει νοειν το αιτιον επισκεπτεον, p. 653.

[9] *Ibid.* iii. 6.

[10] Origen c. *Cels.* ii. p. 67, ed. Spenc.

[11] It was the authority followed by Pliny in his *Natural History*. Pliny, viii. 16, says in allusion to it, "vir quem in his magna secuturus ex parte præfandum reor."

a tract against the doctrines of Xenophanes, Zeno the Eleatic,[1] and Gorgias.[2]

In Mathematics he has left very little. The only treatises extant under this head are, *The Mechanical Questions*, and a book *On Indivisible Lines;* both very inconsiderable works. But he had been trained in the school of Plato, whose threshold was not to be passed by the uninitiated in geometry; and had attained a perfect skill in the method of mathematical investigation then known. We do not want, indeed, more proof of this than is to be gathered from passages in his Physics, in which we find him sometimes establishing conclusions by steps of mathematical demonstration.

Efficient Philosophy.

Dialectic, or Logic.

Aristotle, as was before remarked, was the first to separate the proper science of Dialectic or Logic from that confusion with Physics and Metaphysics in which it had been entangled and perverted. In doing this he laid the foundation of a sound and practical Logic. There was a basis of truth, he saw, in the doctrine of Plato, which referred our knowledge of all sensible objects to certain abstract universal ideas, the objects of pure intellect. But he saw also that Plato had entirely overthrown the right application of the doctrine, by imputing to these universals a positive and distinct being. Instead of treating them simply as principles of classification and grounds of knowledge, Plato's creative genius built the world out of them, resolving all other existences into these as the primary essences and causes of all things. Having stated, then, the proper nature of these universals to be that of conceptions of the mind, by which it represents to itself things, not in that variable character in which they appear, but as they really are, Aristotle further considers them, in the treatises of the *Organon*, as they are employed dialectically, or are subservient to discussion and the communication of knowledge between man and man. There was indeed another view of the application of abstract principles, and prior to that of their employment in discourse, remaining to be considered. This was their use in enabling the mind to connect the phenomena of Nature, or as they are the causes of a proper scientific knowledge. But the state of philosophy in his time did not lead him to such an inquiry. It was reserved for an age of more diffused civilization, and the adventurous spirit of Bacon, to display the principles of that analysis by which the mind arrives at sound general principles, and obtains a real science of Nature. The practice of colloquial discussion on questions of philosophy, recommended as it was by the instructiveness and interest of the conversations of Socrates, attracted the attention of Greek philosophers to the mode of producing conviction by tracing out the connections and consequences of given statements. Aristotle, accordingly, was diverted from the study of the method of Investigation, to explore the application of general principles to the business of Argument. In pursuing this inquiry, he has laid down the principles of a logical science, applicable to the inferences of the reasoner from probabilities, as well as the most rigid demonstrations of the mathematician.[3]

Dialectic, in its original sense (for the term Logic is only of modern use), is the method of deducing the probabilities on either side of a question, which is so framed as to involve one of two contradictory propositions in the answer, according as the affirmative or negative of it is taken.[4] The discussions to which the term Dialectic refers being carried on by a series of questions and answers, the design of the art was to furnish the means of sustaining these intellectual exercises, by supplying not only principles of correct reasoning, or rules of Logic properly so called, but various modes of proof and helps to the invention of arguments.[5] To have a ready command of propositions on any given point, and the objections against it, so as to be completely armed for debate, was the perfect accomplishment of the dialectician. This most obvious application of the science produced unfortunately, in the haste to supply arms for the disputant, instead of a philosophy of Reasoning, a misnamed science, conversant chiefly about the intricacies of verbal quibbling. Zeno the Eleatic, Euclid of Megara, and Antisthenes, took the lead in framing systems according to this view. Nor do the Dialogues of Plato, though rich in examples of reasoning, suggest any more just and exact method. Hence the Logic which prevailed at the time of Aristotle, and which, from the partial acquaintance with his writings, continued, even after his improvements in this branch of philosophy, to be the system of the Greek schools, was a mere collection of subtile points of argument, without any attempt to analyze the process itself of argument. His Dialectic is the reformation of that irregular and perplexed system. Whilst he adopts and explains the general notion of the science, as a method of defending or impugning an opinion, he takes a larger, more philosophical view of the subject; investigating the grounds, both in the nature of language and in the connections of thought, on which all argument must rest. Hence his just boast, that "with regard to the dialectical art, there was not something done and something remaining to be done,—there was absolutely nothing done; for those who professed the art of disputation resembled the rhetoricians of Gorgias's school: for as these composed orations, so the other framed arguments which might suit, as they imagined, most occasions. These their scholars soon learned. But they were in this manner only furnished with the materials produced by the art,—the art itself they did not learn." He goes on in the same passage to observe that "upon Rhetoric much had been written of old; but on syllogizing or reasoning, absolutely nothing; the whole of what he had composed on that subject was from himself;"—that he had "derived no benefit from former labours:" expressing his hope, accordingly, that what he had "left undone would be forgiven, and that what had been discovered would meet with a favourable acceptance."[6]

It is a singular fact in the history of science, that his labours in this arduous work should have suffered an unjust depreciation in modern times, by being estimated in contrast with the analysis of Bacon. According to his own challenge, and as the reason of the case suggests, they admit only of comparison with the efforts of his predecessors, and of the Stoics, who, though following him, wrought upon the ancient model of the science, and elaborated that to its perfection. If we compare the method of Aristotle with what is known of the wrangling discipline of the Stoics, we shall then judge with more fairness of the philosophical cha-

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[1] So called in contradistinction to Zeno the Cittian, founder of the Stoics, from Velia in Italy, his birthplace.

[2] The treatise on plants edited with his works is acknowledged by critics not to be the work of Aristotle, but of Theophrastus. The treatise *De Mundo* may also be regarded as now decidedly rejected from the number of his works, as also the *Collection of Wonderful Narrations*, and perhaps the *Fragment on the Winds;* the internal evidence of these tracts being against their imputed authorship. It is probable that the works of Theophrastus were mixed with those of Aristotle, from the fact of Theophrastus having had some volumes of Aristotle's bequeathed to him, and having used them in the composition of his own.

[3] *Anal. Prior.* i. c. 1 and 30. *Anal. Post.* i. c. 11.

[4] *Top.* viii. cap. 2.

[5] *Top.* viii. cap. 5 *et ult.;* Cicero *De Fin.* ii. cap. 6, and *Top. ad Treb.* cap. 2.

[6] *Soph. Elench.* ii. last chapter.

Efficient Philosophy.

racter of his labours. His disciples were content to be ignorant of such a method as the Stoics taught,[1] though, from its untoward prevalence down to the time at least of Cicero, it has probably been confounded with that of Aristotle, and thus reflected its disrepute on his more scientific system. With the method, however, of Bacon, the Logic of Aristotle has no natural rivalry. In the period of literature preceding the researches of Bacon, it happened that ingenious men, with a natural devotedness to the studies by which their minds had been moulded, sought to resolve the mysteries of science by a profound Aristotelic philosophy. Thus were principles of physics and metaphysics mixed up with the theory of argumentation; as, on the other hand, principles belonging to argumentation had been previously applied to the analysis of nature. The writings of Aristotle were regarded as a kind of Scriptural philosophy, beyond which there was no appeal in controversies of science.[2] And when an authority of this kind is once established, it is easy to see that a mere verbal philosophy will soon follow. Expounding and commenting on the text of the master supersedes the questioning of Nature; just as a mere textual theology supersedes an enlarged study of the facts, and truths, and scheme of Divine Revelation. But this perversion is not to be regarded as the tendency of Aristotle's philosophy. Practically, indeed, he does not keep clear of the seductions of realism. But in him realism is only a *practical* infirmity. Theoretically, he was perfectly aware that "the subtilty of Nature far exceeds the subtilty of human intellect;[3] and that, accordingly, to ascertain *what* things *are*, we must know them otherwise than dialectically. He would have dialectical skill employed for the purpose of stating and examining the questions and difficulties belonging to a subject—not to supersede an acquaintance with phenomena.[4] He observes, that when, in inquiries concerning what a thing is, men are ignorant of the circumstances connected with it, they pronounce only logically and emptily;[5] thus pointing out the futility of applying an instrument of discussion to the real business of philosophical investigation. So far, then, as dialectical art, by sifting a question thoroughly, clearing up apparent inconsistencies, and pointing out where the truth lies, may be regarded as an organ of philosophy, so far Aristotle authorizes the inquirer to employ it. It may serve as the precursor and companion of investigation, but not as the substitute. And thus he describes it as a method of "trying," πειραστικη; whereas philosophy is a method of "knowledge," γνωριστικη.[6] It is quite opposite to his idea of dialectical art to suppose it capable of furnishing the principles of the several sciences. These, he expressly says, belong to the sciences themselves, by which they must be supplied to the dialectician according to the matter in hand.[7] To the philosophical *disputant* they are the *data* with which he sets out; or rather, so far as he is concerned with them, the hypotheses, which he proceeds to discuss in their various points of view, tracing their connection with, or opposition to, other principles.[8] Aristotle, therefore, evidently did not intend that the philosopher, as such, should rest in mere logical speculation. And though he has not provided in his writings an instrument of Investigation, giving only indirect hints of such a method, he supposes it resorted to in practice by the philosopher. His Logic, accordingly, instead of being put in contrast with the *Novum Organon*, is to be regarded as an auxiliary system, introductory to the latter, and tending to enforce its use.

The error of the Schoolmen in applying logical principles to the philosophy of Nature, arose from their misconception of the nature of philosophical truth. They do not seem to have been aware that philosophical principles are but expedients which the mind adopts for connecting and arranging the various objects of Nature. Otherwise, they would have seen that a science conversant about the connections of our notions expressed in language, could not suffice for the investigation, properly so called, of other sciences. When the facts of this science were reduced to certain principles, the whole object of the science was accomplished. The result would be a scientific use of thought and language for the purposes of debate and speculation. To carry this philosophy into other matters, was an incongruity like that of combining principles of mathematics and ethics.[9] There was at the same time a ground for their error, in the universality of language, as the medium by which the truths of every science are expressed; and its comprehensiveness and extent, as it has the power of signifying by single terms an immense variety of objects. These imposing attributes of language gave at least the semblance of philosophizing to their *a priori* speculations. But could they have studied the writings of their master in a freer spirit, their acute minds would have seen the real use to which the universality and comprehensiveness of language might be applied, without trespassing on the legitimate province of Investigation.

A slight consideration of the nature of language may suffice to show the proper business of the dialectician. Language is the record of the observations of mankind on the course of nature. It is, as it were, a popular philosophy. Whatever may be its origin—whether words be merely conventional signs, as Aristotle teaches,[10] or have a foundation in the nature of the things denoted by them—still, their application to observed objects and facts in Nature, is the result of the operation of the human mind; and words, in this use of them, are the creations of the intellect. The intellect takes up and applies the existing signs furnished by language, however derived, to mark and preserve for its future direction the dictates of its past experience. Thus, the application of the term "burning" to the observed effect of fire on a combustible body, is an act of the mind recording its experience of that effect. Having recorded its experience by this term, it thenceforth uses the term as a substitute for the actual experience. Proceeding on that fundamental law of human belief and action, that all things will continue in their observed course, it trusts to the word thus obtained as a guide to future conduct. It is sufficient to say that anything "burns," to give us a representation of the effect of fire, and direct us in our actions with regard to that thing. Accordingly, by the use of terms, observations, in themselves individual facts, are generalized. The term,

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1 Cicero introduces Cato in the character of a Stoic, speaking of the Peripatetics as deficient in acuteness, "on account of their ignorance of dialectic." (*De Fin.* iii. cap. 12.)

2 Where a disputant quoted a passage from this philosopher, he who maintained the Thesis durst not say *Transeat*, but had either to deny the passage, or explain it in his own way. (Bayle, *Dict.*, art. *Aristot.*) He refers, in evidence of this, to the *Courses of Philosophy*, printed in the sixteenth century.

3 Bacon, *Nov. Org.* i. aph. 1.

4 He sometimes expressly adverts to the difference between conclusions drawn εκ των φαινομενων and εκ των λογων, as *De Gen. et Cor.* ii. cap. 10; *Eudem.* i. cap. 6.

5 *De Anim.* i. cap. 1, p. 617, Du Val.

6 *Metaph.* iv. cap. 2.

7 *Anal. Pr.* i. cap. 30; *Anal. Post.* i. cap. 1, 3, 9.

8 Bacon rightly describes the invention which belongs to Logic, in saying, "Inventio enim dialecticæ non est principiorum et axiomatum præcipuorum, ex quibus artes constant, sed eorum tantum, quæ illis consentanea videntur." (*Nov. Org.* i. p. 82.)

9 Aristippus complained of mathematical science, that it gave no account of goods and evils. (*Metaph.* iii. c. 2.) As unreasonable is the complaint of the barrenness of invention of the Aristotelian logic.

10 *De Interpret.*

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originally the record of a single experience, serving practically in the stead of a repeated experience, comes to stand for a number of individuals. From its practical application to a multitude of similar events, it obtains a speculative multiplication as the general expression of many particulars, or, in short, becomes a class-term.

It is thus that language may be regarded as a popular philosophy of nature. Each term denoting some observed object or event, is a general principle, connecting the several objects or events to which it admits of being equally applied. Whilst it practically enables us to judge and act in a number of individual cases, it also speculatively presents the means of anticipating a number of particulars, as notions implied in it; or, in other words, is a *theory* of the particulars which it signifies.

But when we have once obtained a variety of terms, thus representing in each of them a multitude of particulars, we can further generalize our observations by reflection on the notions themselves, and recording our observations on these, in like manner as on the real objects and events of nature. We then notice whether the notions implied by one term, are distinct from, or are included in, the notions implied by another: and, accordingly, we regard the terms respectively signifying them, as classes, either totally distinct, or more or less extensive. We observe, for instance, whether the terms, "man," "animal," "vegetable,"—all being records of our observations on nature,—give us information of the same particulars, or of others entirely different: and we find that "man" and "animal" are but different views of the same individual, as for instance of Socrates; whilst the term "vegetable" is no expression of any observation whatever on the same individual. We find that "animal" represents to us more individual objects than "man;" so we regard it speculatively as a class including in it "man;" and both the terms "man" and "animal," as classes entirely distinct from the class "vegetable," because none of the observations referred to in either of the former are the same with those referred to in the latter.

These principles of language are the data on which the logical system of Aristotle is constructed. It is evident, from the mere statement of them, that there is such a thing as a scientific application of language, and the notions which it expresses, to the purpose of argumentative instruction. It is thus clearly seen to act as an instrument of knowledge by its very nature, independently of any art in the use of it. And it is for the philosopher, therefore, to inquire how it acts in producing this effect.

Now, in order to such a science, the first step appears to be, to reduce *our various observations* on existing things into some definite classes. We thus bring them out of that perplexing infinity which defies all grasp of the intellect, and obtain a few general notions under which the whole intellectual world may be surveyed. These classes will represent to us the different forms or modifications of Being, so far as Being is capable of expression in language. The next step is to examine the principle of Classification in itself, and notice the varieties of form which it takes; as the observations that are made on any individual give us more or less extensive, more or less invariable and scientific, views of the individual. The first step leads us to the Predicaments or Categories, general designations under which all the various abstractions of the mind are conveniently arranged for the purpose of the logician. These constitute, as it were, the fixed land-marks by which he may know the limits of each notion with which he has to do in any discussion. They are the great sections in the geography of the intellectual world which it is his office to explore and describe. The next step leads us to the Predicables, or various modes of classing the same object. Here we enter on that part of the science which is purely logical. In the arrangements of the Categories, the inquiry is partly metaphysical, partly logical. We are there philosophizing on the notions of the mind in connection with language. But here, we examine the principle of classification evidenced in language, *in itself*, and endeavour to obtain comprehensive views of all the varieties of form under which it appears.

Thus far the science of Dialectic was sketched out before the time of Aristotle. The Pythagorean philosopher, Archytas of Tarentum, has the merit of having instituted those arrangements of the objects of the intellect, which Aristotle adopted under the title of *The Categories*. The authority, however, of Simplicius, the commentator in the sixth century, on which such a work is ascribed to Archytas, is extremely questionable. The truth appears to be, that the arrangement itself was of ancient standing in Greek Philosophy, but was unknown as to its origin. It may, however, have been derived through the Pythagoreans, whose mathematical studies gave a colour to all their speculations; as the tenfold division, corresponding with the decimal notation of Arithmetic, would indicate. Whilst the classification, then, was adopted by Aristotle, the discussion of it is evidently throughout his own; strikingly displaying that acuteness of discrimination which is a great characteristic of his mind.

The number of the Categories may be deduced from the following considerations. We may contemplate an object either as to what it is, or what it has; as to its nature, or as to its attributes. 1. If we contemplate it as to its being or nature, it may be regarded, 1*st*, either as a whole complex independent being in itself; or, 2*dly*, partially under some abstract peculiar point of view which still represents its nature, but only indistinctly and inadequately. Under both these aspects it is a being or substance that we contemplate. Being, then, evidently, is of two kinds—Primary and Secondary. Individuals and units, existing alone and independently, are primary beings—those natures which are abstracted from them, and which by generalization become universals, not existing independently of the individuals in which they are observed, are secondary beings. Being or substance, then, under this twofold division, constitutes the 1st Category. The remaining nine, which are the following: 2. Quantity; 3. Quality; 4. Relation; 5. Place; 6. Time; 7. Situation; 8. Habitude or Condition; 9. Action; 10. Passion or Suffering, are all so many different affections or attributes of Being. Each head then, is separately considered by Aristotle, and its limitation exactly drawn. The treatise being further introductory to the whole method of disputation, a method not simply of reasoning, but of producing conviction on any subject, he prefaces it with pointing out, in what sense alone one notion, or rather the term which represents it, can be logically predicated or said of another; and at the end, in that portion of the work which has been called the Post-predicaments, subjoins explanations of the notions "opposite," "contrary," "prior," "co-existent," "motion," "having;" as the terms denoting them were understood in the Greek language.

There is no distinct treatise of Aristotle on the heads of Predicables. This classification, like that of the Categories, is doubtless of ancient date in the schools of Greece. He assumes it as familiarly known, and where accordingly he refers to it with explicitness, it is chiefly to shew its application to the purpose of disputation; as in the first book of his Topics. Here we have nothing to do with individuals as such. We are in the region of universals, and the question is, by what differences they are characterized. Now universals, or the classes which they denote when expressed in terms, can only differ in respect of that which is contained under them. They may combine a number of individuals in one view, differing only numerically from one another; or they may combine several classes, and other classes again may combine these. Thus the ascent may be made continually to a higher class, above which no other appears. Take for

example an action. The first universal formed by abstraction from it might be the notion of Temperance; a second would be that of Virtue; a third would be that of Habit. The first then is a species; the second, as well as the third, is a genus, comprising, as each does, not only individuals, but classes under them. Again, when several such classes are combined in an ascending scale, there must be points of difference distinguishing the lowest, which is the species, from the genus immediately above it, and a lower genus from a higher genus. These points of difference then, also universals, constitute the class of Predicables called differentia, from the service which they perform in relation both to the species and the genus. And thus the genus and differentia put together are said to make up the species; and when stated in words, become the definition of the class to which it applies. But there are universals still of a different character from these. They are such as result from the investigation of any individual or class from tracing it in its relations and consequences, and circumstances. We thus obtain the two additional classes of "Property and Accident." The 4th head, Property, classes all those universals which respect indeed a given nature or being, but not the whole of it, including under it whatever may be observed to result from the three former classifications. The 5th head, Accident, is the general designation of any circumstances in which an object may be observed, which do not result from its being or constitute any part of its nature, but present it in a particular case, or as it exists at a given time or occasion.

This five-fold division (reduced by Aristotle to the four heads of Property, Definition, Genus, Accident, on the ground that Differentia is not distinct from Genus), had its especial importance in the ancient schools of philosophy, and in those of the middle ages. When logic, under the name of dialectic, was regarded as at once a method of philosophy and an art of disputation, there would be a demand for definitions; and questions would be raised as to what was the genus, what the species of the object under discussion; how it differed from others under the same genus—what were its properties—what its circumstantials. Accordingly, in that portion of the *Organon* which is strictly dialectical, *The Topics*, much of the work is conversant about these several heads. They are valid and useful principles to us, both for the purpose of exact logical division and definition in their application to the business of investigation and systematic development of a science. But for the process of Reasoning it is enough that the relative extent of the terms connected in the several propositions be explored, and to see that they rightly express the great fundamental relation of genus and species—or of class extending over class—the general over the particular—the more general over the less general.

In the Categories, then, we have the Metaphysical Being of things, so far as it is denoted by language, drawn out into its various modes, and distinctly characterized in each. In the heads or classes of Predicables, we have the Dialectical or Logical Being, or the various modes of existence created by language, through its power of comprising multitudes under single terms. If, for example, we say "Socrates is wise," the metaphysical being here asserted is an abstraction of the mind, coming under the category of Quality: we are speaking of Socrates, not as he is individually, but as the *quality* of wisdom exists in him. But in the same expression the dialectical or logical being asserted is, the existence of Socrates as an individual in the class to which the term "wise" belongs. And thus the verb *is*, as connecting the two extremes of a proposition, the subject and the predicate, is technically termed the *copula*.

It is highly important to observe this distinction between metaphysical and logical being; as the right understanding of the whole doctrine of propositions and syllogisms is dependent on it. Every proposition then, viewed logically, is the reference of one class of objects to some other class, in the case of an affirmative,—the exclusion of one class from another, in the case of a negative. The "being," or the "not being," is the being implied or not implied in a certain term. The schoolmen, unfortunately, neglecting the distinction here adverted to, and thus reverting to that confusion of logical and metaphysical science which Aristotle's whole philosophy had laboured to remove, included both kinds of being under the common term "universals." Evidently, however, it cannot properly be said of Being, as it is apprehended by the mind, that it is a universal. A notion of the mind is in itself an individual; and its extension to more objects than one is an effect of the mental power of generalization. But the logical being is by its very nature a universal; since a term, so far as it is a sign, comprises in its extent every individual that admits of being referred to it as a class.

Accordingly, to examine propositions logically, we have only to inquire into the relative extent, or relative exclusion, of the terms conjoined in it. In this point of view, all propositions, on any subject whatever, are reduced to four kinds;—Universal Affirmative, in which one class is affirmed of the whole of another; Universal Negative, in which two classes are mutually excluded; Particular Affirmative, in which one class is affirmed of some of the particulars included in the other; Particular Negative, in which one class partly excludes another. These are the only varieties of form under which any two classes of objects can be combined in affirmations or negations. Every proposition, accordingly, in order to be brought under the survey of Logic, must be referred to one or another of these forms, as the case may be. Hence we may proceed to examine these ultimate forms to which propositions are reducible, independently of the things themselves about which the propositions are; and draw from them logical principles applicable to every particular case. Thus, the form of a Universal Affirmative, "every A is B," in which the letters A and B are put as the representatives of any objects whatsoever, is the proper datum, from which the whole logical nature of any Universal Affirmative Proposition may be explored. So also with regard to the remaining abstract forms.

Aristotle, accordingly, in his treatise on *Interpretation*, and in the commencement of his *Prior Analytics*, has thus examined the nature of Propositions, and deduced practical rules by which their force as principles employed in reasoning may be readily ascertained.

It has been objected to him, that he resorted to these abstract symbols rather than to more familiar means of illustration, in order to leave the truths of the science partially veiled. There may be some truth in the assertion, that he did not intend his written works to be accessible to the public without oral exposition. But it does not apply here. The observation already made on the nature of logical being, may be sufficient to clear up any misconstruction on this point. The principle of classification, which is all that Logic, as the science of reasoning, is concerned with, could not be examined so scientifically and clearly in any other way as in that which expresses the principle itself nakedly. Every thing else is irrelevant to the matter in hand. So far as anything else is attended to in a proposition, so far the mind is diverted from the logical point of view. His use of symbols, therefore, is only an illustration of his accurate and perfect method of developing the science.[1]

In his *Prior Analytics* he passes on to the consideration of Syllogisms, or arguments logically viewed. Here it is that the logical theory is properly unfolded. Syllogisms are

[1] The use of unmeaning symbols in logic rests on the same footing as their use in geometry and algebra.

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the perfect developments of the theory of language, as language consists of signs expressive of Being,—manifestations of the general fact, that every term denoting Being is the representative of a class of observations more or less extensive, on some subject.[1] This theory is first intimated in the ordinary use of single terms. It is next more disclosed in the connections of terms *i. e.*, in propositions affirming or denying one term of another. It is lastly laid open in the syllogism, in which the principle of classification is fully exemplified as the tie of connection between two terms affirmed or denied of each other.

Since, then, the evidence of the connection subsisting between the terms brought together in any affirmation or negation is *the point* in every argument; it is evident that the reasoning on any subject whatever may be exhibited abstractedly from the particular subject about which it is. Terms can only be connected as they are classes more or less extensive, relatively to each other; and this relative extent is evidenced at once, as before shewn, by the abstract forms of the propositions in which they are connected. Three abstract propositions, accordingly, in which the terms whose connection is explored, are, first (*i. e.*, in the two premises), separately stated in their relation to some intermediate class or middle term,—and then in their relation to each other (*i. e.*, in the conclusion), as it is the result of their premised relations to the intermediate class,—will enable us, without reference to any other consideration, to judge of the conclusiveness of the argument. The Syllogism is nothing more than this abstract statement of an argument.

Aristotle examines all the varieties of form which arguments thus abstractedly stated, or syllogisms, admit; whether from the position of the middle term in the premises, or from the different combinations of the four great classes of propositions; pointing out, under what arrangement of the middle term, what particular modes of argument alone are valid. From his whole examination, the conclusion results, that, under whatever form an argument may be expressed, the principle of the reasoning is the same in every case; each instance developing the theoretic power of language, according to which every term, so far as it denotes Being, is a class, more or less extensive, of observations on the thing whose being it denotes.

This ultimate principle of all reasoning is commonly stated in the form of a theorem, enunciating that "whatever is predicated (affirmed or denied) universally, of any class of things, may be predicated in like manner of anything contained in, or signified by, that class." This is that form of it known by the scholastic designation of the "*Dictum de Omni et Nullo.*" From the mode in which this principle has been introduced in systems of Logic founded on the method of the school-authors, a prejudice has been excited against Aristotle, as if he had employed the principle in establishing the conclusiveness of arguments already granted to be conclusive. Aristotle, however, does not introduce the principle in any formal manner, as a dogma or *a priori* ground of logical truth. On the contrary, it pervades the whole of his system, as resulting from every part of his inquiry. He is only concerned to shew that every argument, however varied in its mode, or form, is reducible to a form by which the truth of the theory shall be evidenced in it. Syllogisms are not proved by the principle; but the principle itself is proved by the nature of the syllogism, as any other philosophical truth is deduced from varied observations and experiments. In short, by his reference to the principle, he does not *prove* the conclusiveness of a given argument, but *accounts* for it.

It is necessary to observe that most of the technical phraseology of modern treatises of Logic is derived, not from Aristotle immediately, but second-hand, from the scholastic expositors of his philosophy. These, in carrying the notions of his Physics and Metaphysics into the science of Logic, obscured, by the strange dialect in which the truths of the science were thus delivered, its proper nature as an art of language. Thus, according to them, we hear of the "substance," and "matter," and "form," both of propositions and of syllogisms, and other such misapplied designations. On the contrary, the technical expressions of Aristotle himself are extremely few, and those strictly appropriate to the subject, elucidating the characteristic nature of a science conversant about words as they are signs of thought. The scholastic method, however, from its long usurpation, has so ingrafted itself on our modes of writing and speaking, that some acquaintance with it is in fact become necessary to us at this day; and may so far, therefore, be regarded as constituting a legitimate part of modern logic. But when the cumbrous technicalities of this system are made a ground of objection to the Aristotelic logic, it may be explicitly answered, that these are not parts of Aristotle's system, as it is found in the original, but the refinements of his commentators.

Having pointed out the several classes of Syllogisms into some one or more of which every valid argument must fall, Aristotle, in pursuit of the adaptation of his method to the business of disputation, proceeds to shew the various expedients in argument resulting from the consideration of these abstract forms. This part of his subject is prosecuted through the remainder of the first book of his *Prior Analytics* and the second of the same treatise.

The examination of Syllogisms is followed up in the *Posterior Analytics* by an inquiry into Demonstration; and in the *Topics*, into arguments founded on probable premises. The full discussion of the Syllogism was premised by him, inasmuch as the syllogistic process is common both to demonstration and to probable conclusions; and accordingly, as the more general subject of investigation, claimed the first notice in a scientific treatise of Dialectic. Properly, indeed, being the only part of the science which is really universal,—belonging to argumentation *as such*, under whatever form, whether by induction, example, or enthymeme (all of which are only different modes of expression of the syllogism), and whether the premises assumed be necessary or probable,—it is the only province to which the science of Reasoning, in its strictest sense, extends. In examining further the nature of demonstration and of probability, we depart from the rigorous limits of the science of Reasoning, and approach those of Rhetoric. But it is useful, at the same time, to examine these subjects as detached from Rhetoric, and in their connection with Logic; so far as we then confine our attention to the mere force of different kinds of argument on the *understanding;* whereas Rhetoric combines also the view of them in their effect on the *will.* We then consider them as they are capable of producing either knowledge or opinion; whereas in the latter case, we look at them in that complex result which is implied in persuasion. It was for the former purpose that they were required for the disputant: and thus it is that the consideration of them forms an important part of the several dialectical treatises which pass under the name of the *Organon.* For the same reason the concluding treatise on *Sophisms* is directed not only to the solution of Fallacies which may exist in the syllogistic process, or in reasoning, strictly viewed as reasoning, but to such also as may be traced in arguments where the process itself, the pure logic of the case, is perfectly correct.

The discussion of Demonstration is an exposition of the nature of Science, Επιστημη, as it was understood by the ancient philosophers. They restricted the application of the

[1] A *proposition* that is false is truly a proposition, whereas what is called an *invalid* argument is strictly no argument at all, because it does not exemplify the classification implied in the logical connection of terms.

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term to the knowledge of necessary truths; such truths as, when known, were known at the same time to be incapable of being otherwise. Aristotle, then, is employed, in the *Posterior Analytics*, in discussing the nature of the principles on which Science, as it was then understood, must be built.

Here he had to encounter perplexities and misconceptions introduced into the subject by the Platonic philosophy. In Plato's system knowledge was mere reminiscence. It was a penetration of the mind through the veil of sensible things interposed between itself and the realities of the intellectual world—its return to those purer perceptions which it had enjoyed before its present union with a body. This doctrine was altogether founded on a fallacious view of the nature of Demonstration. Because in Demonstration the conclusion is necessarily implied in the premises, it was conceived that a science or proper knowledge of any particular was in all cases founded on a knowledge of the general principles in which it was implied. But this was an inversion of the actual order of knowledge, which commences with the particular, and ends in the general. In mathematical and metaphysical science the two things coincide; the notions of our mind being, on the one hand, in themselves particular facts, from which we may argue to general principles; and, on the other hand, in their application to the business of philosophy, being the general principles of our knowledge. But Plato argued from this coincidence in these sciences in general, and therefore confused Demonstration with the scientific arrangement of facts. Aristotle, we find, was not free from the same fault in his Physics; but in his theory of Demonstration he has strictly provided against it. He has here pointed out the difference between the proof of matter of fact and matter of abstract speculation. Instead of inculcating the necessity of establishing every conclusion in Science by syllogism or a demonstrative process, he shews that all Demonstration proceeds on assumed principles; which principles, accordingly, must be obtained from observations generalized, and not by a process of reasoning from the general to the particular.[1]

There is one part of the work which deserves a more particular notice, as throwing light on his whole method of philosophizing, while it shews how far he approximated to the Induction of modern philosophy. To obtain an accurate notion of the being of any thing, we require a definition of it. A definition of the thing corresponds, in Logic, with the essential notion of it in Metaphysics. This abstract notion, then, according to Aristotle, constituting the true scientific view of a thing,—and all the real knowledge consequently of the properties of the thing depending on the right limitation of this notion,—some exact method of arriving at definitions which should express these limitations, became indispensable in such a system of philosophy. But in order to attain such definitions, a process of induction was required—not merely an induction of that kind which is only a peculiar form of syllogism, enumerating all the individuals implied in a class instead of the class itself—but an induction of a philosophical character, and only differing from the Induction of modern philosophy so far as it is employed, not in the limitation of facts, but of the notions of the mind in their expression by words.

There are, then, two kinds of Induction treated of by Aristotle. The first, that of simple enumeration. Its use is, where we have not beforehand ascertained a class to which we may refer the subject under consideration, and the search is in fact for a middle term. In this case, then, a collection of all the individuals which are supposed to make up the class, serves instead of a middle term. Assuming, accordingly, that these individuals are equivalent to the class, we draw the conclusion, that what has been affirmed or denied of each of these collected individuals may be affirmed or denied of the class, or the universal which they represent. This, then, is nothing more than a syllogism. There is no process of investigation involved, but it is assumed, that we have found the assertion made, true in all the individual instances; and the induction itself is simply the process of bringing them under a common principle.

But there is also a higher kind of Induction employed by Aristotle, and pointed out by him expressly in its subserviency to the exact notions of things, by its leading to right definitions of them. As it appears that words, in a logical point of view, are classes, more or less extensive, of observations on things, it is evident that we must gradually approximate towards a definition of any individual notion, by assigning class within class, until we have narrowed the extent of the expression as far as the case requires.[2] The first definitions of any object are vague, founded on some obvious resemblance which it exhibits compared with other objects. This point of resemblance we abstract in thought, and it becomes, when expressed in language, a genus or class, under which we regard the object as included. A more attentive examination suggests to us less obvious points of resemblance between this object and some of those with which we had classed it before. Thus carrying on the analysis,—and by the power of abstraction giving an existence to those successive points of resemblance,—we obtain subaltern genera or species, or subordinate classes included in that original class with which the process of abstraction commenced. As these several classifications are relative to each other, and dependent on the class with which we commenced, the definition of any notion requires a successive enumeration of the several classes in the line of abstraction; and hence is said technically to consist of genus and differentia; the genus being the first abstraction, or class to which the object is first referred, and the differentia being the subordinate classes in the same line of abstraction.

Now, the process by which we discover these successive genera in forming a definition, is strictly one of philosophical Induction. As in the philosophy of nature in general, we take certain facts as the basis of inquiry, and proceed by rejection and exclusion of principles involved in the inquiry, until at last,—there appearing no ground for further rejection,—we conclude that we are in possession of the true principle or nature of the object examined; so in the philosophy of language, in drawing forth an exact outline of any notion, we must proceed by a like rejection and exclusion of notions implied in the general term with which we set out, until we reach the very confines of that notion with which our inquiry is concerned. This exclusion is effected in language by annexing to the general term denoting the class to which the object is primarily referred, other terms not including under them those other objects or notions to which the higher general term applies. For thus, whilst each successive term in the definition, in itself, extends to more than the object so defined, yet all viewed together do not; and this their relative bearing on the one point marks out and constitutes the being of the thing.[3] This is thus illustrated by Aristotle:—"If we are inquiring," he says, "what magnanimity is, we must consider the instances of certain magnanimous persons whom we know, what one thing they all have so far forth as they are such; as,—if Alcibiades was magnanimous, or Achilles, or Ajax,—what one thing they all have; say 'impatience under insult;' for one made war, an-

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[1] *Analyt. Post.* ii. c. ult. 7, 4, i. 13.

[2] *Ibid.* ii. c. 13, Ζητειν δε δει επιβλεποντα επι τα όμοια και αδιαφορα, πρωτον τι άπαντα ταυτον εχουσιν, κ. τ. λ. p. 175, Du Val.

[3] *Analyt. Post.* ii. c. 13, ὡν ἑκαστον μεν επι πλειον ὑπαρξει, άπαντα δε μη επι πλειον ταυτην γαρ αναγκη ουσιαν ειναι του πραγματος, p. 173, Du Val.

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other raged, the other slew himself: again, in the instances of others, as of Lysander or Socrates,—if here it is, 'to be unaltered by prosperity or adversity;'—taking these two cases, I consider, what this 'apathy in regard to events,' and 'impatience under insult,' have the same in them. If now they have nothing the same, there must be two species of magnanimity."[1] So, again, he suggests a similar process in order to ascertain the nature of anything. He directs that the investigation should commence from the genus; since, having discovered the properties or sequences of the genus, we have also the sequences to the next class in the series,—and so on from that class to the next below in order,—until by this continued process we reach the individual object examined. In the course of investigation, also, he observes, that we should attend to whatever is common, and examine to what class of objects that belongs, and what classes fall under it;[2] and for the same reason select analogies; since, in both these instances, we obtain genera, under which the object investigated may be arranged. The process is virtually the same as if we should investigate a fact or law of nature. But the Induction of Aristotle, having for its object to determine accurately in words the notion of the being of things, proceeds, according to the nature of language, from the general, and ends in the particular; whereas the investigation of a law of nature proceeds from the particular, and ends in the general. In the process each kind of Induction is an analysis. But logical Induction is synthetical in the result, whilst philosophical induction is analytical throughout. The former labours to particularize as much as possible, counteracting the uncertainty occasioned by the generalizations of language, whilst the latter is engaged in penetrating the confused masses in which objects first present themselves to the mind, and exploring their most general and characteristic form. Thus the induction of Aristotle was strictly επαγωγη, or the bringing in of notion on notion, each successively limiting the application of the preceding one in regular series, so as at length to present a distinct notion of the object defined.[3] The notion thus obtained in words is the *logos*, or expressed reason of the being of the thing; and hence perhaps the prevalence of the name Logic[4] as appropriate to this branch of science, instead of the more general and ancient designation of Dialectic,—which expresses rather the application of the science to the ancient mode of disputation, than its philosophical nature.

It would appear, then, that Bacon has not done justice to Aristotle in the contemptuous manner in which he has spoken of the Induction taught by Aristotle. It is certainly limited in its design, as having chiefly in view the correct statement of the particular notions on which an inquiry turns, rather than the discovery of new truth: and it is not set forth with that fulness of method with which Bacon enterprised the *Novum Organum*. But it is sound and valid so far as it reaches; and it shews that Aristotle was not intent on corrupting philosophy with Logic, but rather on applying Logic to that very purpose which Bacon himself so much insists on—the bringing the intellect even and unprejudiced to the business of Science. Of the application of Induction in its full philosophical extent, Aristotle presents abundant specimens, and particularly in his treatises on Ethics and Rhetoric. His discussion of the Passions in the latter treatise is a masterpiece in that way. He sets out, indeed, abstractedly with definitions of the several passions, but these are the results at which he has arrived by Induction; being obtained, as his subsequent observations shew, by a close interrogation of Nature; by examining accurately what belongs, or does not belong, to each particular passion,—and thus eliminating its exclusive character and proper nature.

Rhetoric.

As the Speculative Sciences had been confounded under a vague notion of dialectic, so had Rhetoric, in the ostentatious study of it prevalent before the time of Aristotle drawn into its system the practical sciences of Politics and Ethics. Observations had been accumulated on the mere accessories of the art; but the proper business of the rhetorician—the inquiry into the argument itself of which a composition must consist—had been overlooked. Aristotle had therefore to dig a foundation for the fabric of a real science of Rhetoric. He had to clear away misconceptions; to shew the data on which Rhetorical science must proceed, and the relative importance of its several parts.

He commences, accordingly, with pointing out the nature of its connection both with Dialectical and Moral science. It is first and most directly connected with Dialectic, inasmuch as it is a general method of providing arguments on any subject whatever. As Dialectic examines and discusses the principles of various sciences, considering them in their relations as principles in the abstract, and not as the principles of this or that science, and is so far equally conversant about all subjects; so Rhetoric inquires generally into the nature of the principles of Persuasion, and therefore is also of equal application to the various subjects of human thought. In the discussion of these abstract principles under the head of Dialectic, it is found that they are referable to two general classes—that they are either probabilities or necessary truths. And Aristotle, accordingly, after having explained the nature of Syllogism, or the more general connection of principles, which is independent of their peculiar nature, proceeds to investigate the nature of deductions as drawn from necessary principles or from probabilities. The consideration of this distinction anticipates in some measure the province of Rhetoric, touching on the point, as has been observed, in which Rhetoric differs from Logic strictly so called. As the science of eloquence, its office is to speculate on the effect of different principles in producing persuasion, and not simply on their abstract relations; and therefore it must examine the force of arguments, whether probable or necessary, in their influence both on the judgment and the will. Principles, in short, as they are grounds of Credibility, and not as they enter into a reasoning *process*, constitute its proper subject. In this respect it coincides with a part of the ancient Dialectic. But it differs, again, from Dialectic, inasmuch as it is connected also with Moral Science. In Dialectic the force of man's moral nature on his opinions is not considered. Will such or such a conclusion result from such or such arguments, according to the procedure of the human intellect in forming its judgments? is the whole inquiry of Dialectic. But Rhetoric further considers, what is the practical force of such and such arguments? what effect are they found to have in actual experience?—not according to their mere speculative truth, but as acting on the complex nature of man. Practically, it is found that questions are not examined on their positive merit as simple questions of truth, but with feelings and sentiments thwarting or aiding the discernments of the intellect. Here, then, is opened a wide field for a philosophical inquiry of a peculiar character, distinct from Dialectic, and yet strictly founded on it, and implying it throughout, as well as of the highest importance in order to the success of truth in the world. This inquiry is what Aristotle institutes under the head of Rhetoric.

He has evinced the most perfect comprehension of the nature of the science which he had undertaken to develop, in holding it, as he does, in exact balance between the two sciences of Dialectic and Morals with which it is associated.

[1] *Anal. Post.* ii. c. 13, p. 175, Du Val. [2] *Anal. Post.* ii. c. 14. [3] *Anal. Prior.* ii. c. 23.

[4] Aristotle uses the adverb λογικως, as in *Met.* vii c. 4, and elsewhere; but not the noun λογικη to denote the science, and only Διαλεκτικη.

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There is much of logical matter in the course of his inquiry, and still more of ethical. But he never suffers us to forget that we are not examining those sciences *in themselves* under the head of Rhetoric, but in their relations to a science compounded of both. He would have the rhetorician versed in Dialectic, and deeply acquainted with human nature. But he is intent on shewing how he is to apply his knowledge of both these sciences to the proper business of Rhetoric—the influence on the heart and mind of the person addressed. It is not a vague and popular knowledge of those sciences which he is inculcating throughout, but a popular application of authentic principles drawn from them both, and a popular application founded on a deep philosophy of human nature.

This philosophy consists in an investigation of the kinds of Evidence by which the minds of men are commonly swayed in accepting any conclusion proposed to them, and of those principles of their moral nature which generally induce belief. The whole, accordingly, is an inquiry into what is probable, or rather what is credible and persuasive, to a being so constituted as man.

Rhetoric, then, does not consider arguments as they are abstractedly necessary or probable. Such arguments appeal to the intellect alone; and the result from such is, either a full conviction, or a presumption of some point in question. Rhetoric, on the other hand, looks to probability in the *result*. Whether an argument be necessary or probable in *principle*, is comparatively of no consequence to the rhetorician, provided it be persuasive in its *effect*. He has to consider, therefore, only a probability of this kind—on what grounds men commonly *believe* an argument to be just, or are *influenced* by any statement.[1] Now men are found to receive arguments as conclusive on two different grounds—from considering them either as logically sound, deducible from admitted principles, or as coincident with some previous observation or fact. Hence the distinction between probability and likelihood; probability denoting conclusions proved by some reason alleged; likelihood denoting conclusions grounded on matter of fact, the conclusion being something like what has been experienced. Aristotle distinguishes these two kinds of rhetorical arguments as probabilities, εικοτα, and signs, σημεια. The precise nature of the distinction he explains more fully in his Analytics.[2] In his Rhetoric he directs our attention rather to those practical forms which the two classes assume in Enthymemes and Examples; Enthymemes being probable arguments which state a conclusion with the reason of it, but without the formality of a syllogism; such as occur in familiar use; Examples, arguments in which a conclusion is drawn from particular facts or observations.

He points out, accordingly, the force and propriety of Enthymemes and Examples, as modes of producing conviction, both in themselves, and relatively to each other, according to the subjects in which they may be employed. And as Enthymemes are the more comprehensive head—for, in fact, every argument from Example is in principle an Enthymeme, the example cited being the reason of the conclusion,—he dwells more explicitly on the nature of Enthymemes. These he distinguishes in respect of the principles from which they are drawn. These principles may be, 1. Entirely abstract, unconnected with any particular subject, and equally common to all subjects; or, 2. They may belong to particular subjects, and the sciences of those subjects. Instances of the former class, called by the general name of Topics, or common places, are conclusions of the possibility of any thing from abstract considerations of possibility,—of the existence of anything from the existence of that which implies it more or less, &c. Instances of the latter, ειδη, or specific Topics, are conclusions drawn from the nature of human actions, or from some principle of government or commerce, or whatever it may be to which a speaker or writer has occasion to refer.

The matter of proof, or the grounds of Credibility in themselves, being obtained, it comes, in the next place, to be considered how this proof is acted on and modified in the result by the complex nature of man, on whom the result is to be produced. The subjects then, to which rhetoric properly applies, are those in which there is some opening for the action of the moral feelings. In questions of pure science the intellectual powers alone are concerned. There is no personal application to the individual; no reference to his own experience for the proof of the principles, as is the case with all inquiries involving human conduct; where a fairness of judgment is as much required in order to an acknowledgment of the principles, as a clearness of intellect. Whatever may be the nature of a mathematical enunciation or a fact in chemistry, when it is once stated and proved, there is no question whether we approve or disapprove it. Its truth is suffered to rest on its proper footing. But a conclusion respecting our own nature, or involving our own conduct, immediately calls all our moral principles to the survey of it. Our hopes, and fears, and wishes, are heard pleading for or against it. Here, then, is the proper province of the rhetorician. He is to furnish principles to the advocate by whom the case is to be laid before these internal judges; to suggest how to prepare the evidence for their reception; and by his knowledge of their former judgments, to enable him to present the truth before them in such form, that it may obtain a fair hearing, and be affirmed in their decisions.

For the convenient arrangement of rhetorical arguments, Aristotle divides Rhetoric into three different kinds, according to the different occasions on which it was employed among the Greeks:—1. The Deliberative, or its use in political debates; 2. The Judicial, or its use in popular assemblies, as those of Athens, in which the people collectively exercised the judicial functions; 3. The Demonstrative, or its use in panegyric and invective, when the orator had to gratify his hearers by the display of eloquence.[3] In these several heads of inquiry he has given an admirable account of the motives by which mankind at large are commonly actuated in their conduct and opinions. And here we should notice the peculiar complexion which the Happiness and the Virtue, described in this part of his philosophy, assume. He is led to speak of Happiness[4] as the great object of human desires—the point from which all views of expediency obtain their colouring. Here, however, he is not concerned to illustrate that Happiness to which the aim of mankind *should be* directed, but that which is *in fact* sought in the world as it is. He therefore portrays those various forms with which self-love commonly invests the idea of happiness. For it is evidently more to the purpose of the orator, whose object is to carry his point, to conform his arguments to the views entertained by his hearers, however theoretically false, than to a more just theory, of which they have no conception. Virtue, again, is here a law of Honour.[5] It is an appeal to those right feelings which exist in the nature of man, by which virtue is approved and vice disapproved. Independently, however, of discipline and cultiva-

[1] When it is asserted, that Dialectic is concerned about truth, and Rhetoric about opinion, this must be understood to mean that Rhetoric has for its object to discover, not what any particular thing *is*, but what will give a *persuasion* or *belief* that it is. At the same time, those principles on which such a persuasion depends, are real truths about which the science is conversant.

[2] *Anal. Prior.* ii. cap. ult; *Rhet. ad Alex.* cap. 9, 13, 15.

[3] *Rhet.* i. cap. 3, &c.; *Rhet. ad Alex.* cap. 2–6, 35–38.

[4] *Rhet.* i. cap. 5.

[5] *Ibid.* i. cap. 9.

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tion, these feelings are not found in fact always duly exerted. There is ground, therefore, for a popular kind of Virtue, in a philosophical survey of those principles by which the human heart is *commonly* swayed in its decisions of right and wrong. This popular law of right is at least an approximation to perfect virtue. It is an irregular and uncertain application of the criterion of approbation, which belongs to true virtue alone; leading to a preference of the more ostentatious virtues to the less obviously praiseworthy; and to the exaltation of some qualities merely specious, or even faulty, to the rank of virtues, through the want of discrimination and corruption of principle in the world. Thus Virtue becomes, in the popular view, a power of benefiting others,[1] rather than an internal habit of self-moderation. Men acquiesce in that general notion of it, under which it most strikes their attention, and calls forth their admiration. Such, then, is the kind of Virtue to which the orator must make his appeal. He cannot calculate on finding the bulk of his hearers moral philosophers, or persons whose sentiments have been highly cultivated. He must therefore proceed on those broad principles which may be presumed to exist in the heart of every man though imperfectly cultivated. It is to these he must conform his arguments, if he would produce that impression which he desires.

Further, as the habits of thinking and feeling among men are found to be affected by peculiarities of circumstances, it is necessary for the orator to have studied also the varieties of human character, and to have reduced these to general principles for his practical direction. Aristotle, accordingly, has not lost sight of this point in his Rhetoric, but has shewn a keen observation in the outlines which he has given of the effects of different governments, different periods of life, different worldly fortunes, in modifying the human character.

He had strongly condemned former rhetoricians for making the whole art consist of an appeal to the Passions. At the same time, he was aware that such an appeal was a necessary part of the orator's address; and that no arguments, no merely intellectual proofs, could avail, independently of this. To overlook, indeed, the affections in arguments concerning human conduct, is to disregard the authorities to which the whole process of proof is ultimately addressed. Wherever evidence is not absolutely irresistible, and there is room for doubt,—though the object be simply to induce belief,—the hearer naturally proceeds in his analysis of the evidence, until he brings it home to himself, and finds it issuing in something natural to his own character and feelings. This it is that at last determines the wavering balance. The philosophy of Rhetoric, therefore, required some outlines to be given of these ultimate arbiters of all rhetorical questions. And we are indebted accordingly to his masterly view of the subject, for an accurate and beautiful delineation, in the course of this treatise, of the leading Passions of human nature. Of its excellence as a specimen of the Inductive method of philosophizing we have already spoken.

In treating both of the Virtues and of the Passions, Aristotle's view was to enable the orator, not only to recommend his arguments to the moral sentiments and feelings of an auditory, but to bring also to their support the natural and just prejudice from Authority. We involuntarily ascribe to one who appears in the character of an instructor, the advantages of superior knowledge and kind intentions. The prejudice in favour of Authority is thus reasonably founded on a respect for wisdom and virtue. It is important, then, to the orator to avail himself of this prejudice. There must be nothing to counteract, in those addressed, the natural tendency to believe the speaker. On the contrary, his whole address must conspire to this end. It must give the impression that he is a man of intellectual ability, as well as of right sentiments and feelings. Hence Aristotle deduced a distinct class of rhetorical proofs under the head of, 1. *Ethos*, or character; 2. The *Pathos*, or appeal to the passions; and 3. The Demonstration, or argumentative proof as such, constituting the two other heads. He thus shews, on the whole, how a speech may at once carry conviction, interest the feelings of the hearer, and give the weight of personal authority to the speaker.

In the popular views of Rhetorical science, the subjects of style and method engross an undue importance. We are thus led to think that eloquence consists in the skilful use of the ornaments of style, in the flow of periods, and the structure of a composition advantageously distributing its lights and shades. The attention is diverted from the material itself of eloquence, the strong framework of argument, without which no eloquence can subsist. Aristotle, in proceeding to the discussion of style, has cautiously maintained the subordination of this part of Rhetoric to the proper business of the art—Persuasion; treating it as a necessary condescension to the weakness of the hearers. If, however, the manner in which we express our thoughts may contribute to the reception of our assertions and arguments, and it be allowed that the principles of Taste are real parts of the human constitution,—the consideration of style must necessarily enter into a philosophical system of Rhetoric. The effect of the style is part of the whole result of the composition on the mind of the hearers, and is so far, therefore, an ingredient in that Probability or Credibility about which Rhetoric is conversant.

In conformity with this view of the importance of style, Aristotle lays down perspicuity as the great principle of good composition. It is with him "the virtue of style."[2] All the ornaments of language, whether from the structure of periods, or from the various modes of thought by which a point, or a propriety, or a dignity, or an animation, is imparted to a subject, are explained in reference to this fundamental law.

Nor has he left unconsidered the arrangement of the parts of a speech; though this also was in his opinion scarcely a legitimate portion of the art. Former rhetoricians had encumbered their systems with numerous artificial divisions, giving precise rules for the composition of each distinct head. Aristotle's more exact method admits no other divisions than the Proposition and the Proof; the former founded on the necessity of stating the subject of discussion, the latter on the necessity of proving the point stated: though he afterwards allows the convenience of a fourfold division into, 1. The Proem or Introduction; 2. The Proposition; 3. The Proof; 4. The Epilogue or Peroration.

So deeply and fully has the science of Rhetoric been considered by Aristotle. His treatise on the subject, the *Rhetoric*, in three books, addressed to his disciple Theodectes, and his *Nicomachean Ethics*, are perhaps the most perfect specimens of systematic sciences extant in ancient or modern literature. For extent and variety of matter, the *Rhetoric* may be ranked even above the *Ethics*. It has been justly characterized as "a magazine of intellectual riches. Nothing is left untouched" says one who could well appreciate the value of the work, "on which Rhetoric, in all its branches, has any bearing. His principles are the result of extensive original induction. He sought them, if ever man did seek them, in the living pattern of the human heart. All the recesses and windings of that hidden region he has explored; all its caprices and affections—whatever tends to excite, to

[1] *Rhet.* i. cap. 9, αρετη δε εστι μεν δυναμις, ὡς δοκει, ποριστικη αγαθων και φυλακτικη· και δυναμις ευεργετικη πολλων και μεγαλων, και παντων περι παντα.

[2] *Rhet.* iii. 2. *Poetic.* c. 22.

ruffle, to amuse, to gratify, or to offend it—have been carefully examined. The reason of these phenomena is demonstrated; the method of creating them is explained. The whole is a text-book of human feeling; a storehouse of taste; an exemplar of condensed and accurate, but uniformly clear and candid, reasoning."[1] It is professedly adapted to the business of the orator, that being the original occasion of an art of Rhetoric. But it is in fact a body of precepts for good writing, furnishing authentic principles of criticism in every department of prose composition. His smaller treatise in one book, entitled *The Rhetoric to Alexander*, the genuineness of which is questionable, is more strictly a science of political eloquence, being written, as the introductory address would intimate, in obedience to the King, who had requested a work of that description.[2] The same philosophical views of eloquence may be traced in this work; but more popularly set forth, with less of technical precision, and more of illustration from examples.

Poetics.

No work of Aristotle has been more justly estimated than the fragment which has survived to us under the name of his *Poetics*. Imperfect as it is, it has been uniformly regarded as the great authority of the laws of criticism in poetry: subsequent writers having only extended and illustrated the principles laid down in it. The excellence of this little work, which is only one book of the three of which the whole treatise is said to have consisted,[3] shews how much we have to regret the entire loss of his other works on the same subject. The treatises *On Tragedies* and *On Poets*, mentioned in the catalogue of Laertius, probably contained much valuable information concerning Greek writers, whose works, perhaps whose names in some instances, have not been transmitted to us.

That portion which time has spared of the *Poetics*, is almost exclusively confined to the consideration of dramatic poetry. But the philosopher, with his usual depth and reach of thought, has here laid a broad foundation of principles applicable to the whole subject. He derives the nature of poetry in general from the principle of Imitation inherent in man. Two natural causes, he says, appear to have originated poetry; the natural power of imitation,—and the pleasure which all men take in imitation, that is, in recognizing likenesses between distinct objects. These two causes thus stated by him are in fact but one principle: the pleasure resulting from imitation being the principle itself of imitation, viewed in its tendency or proper effect, the production of pleasure: though, in the language of his philosophy, the first would be the motive cause, the second the final. The science then termed Poetics, is that which treats of the method by which the natural principle of Imitation obtains its proper and full expression; or a collection of observations on the mode by which pleasure is produced in imitations of which language is the instrument. Hence the business of the Poet is stated by Aristotle to consist in representing things, not "as they have been, but as they ought to be;" and therefore is described by him as of a more philosophical and excellent nature than that of the historian.[4] The pleasure of Imitation will not be answered, unless a likeness be recognized between the objects and events described, and the objects and events observed in the general course of nature. Otherwise it will be a mere pleasure in the execution, or in some circumstance of the work. The poet, therefore, in order to accomplish the end of his art, must possess a philosophical power of observation. He must have compared objects and events, and detected points of resemblance, and thus formed for himself general principles on which he may proceed to model his ideal world. At the same time he differs from the philosopher much in the same way in which the orator differs from the dialectician. He has not to consider what is *abstractedly* like in things, but what will be viewed and felt as like in its *effect* on the sentiments and feelings of men. Therefore it is that his creations are clothed with a beauty and loveliness surpassing nature. The resemblances which he shadows out partake of those hues, which the imagination, and the feelings, and every beautiful and noble sentiment of the heart of man, reflect upon them.[5]

These fundamental notions of the art pervade the system of Aristotle's Poetics, though, from the briefness of the work in its present imperfect state, they are by no means fully developed in it. In the work, indeed, as it now is, the basis of the poetic imitation—the actions, passions, and manners, of which a poem is descriptive—are exclusively considered; and we have no inquiry, as in the Rhetoric, into the principles of human nature by which the pleasure resulting from the imitation is modified in its effect. From this circumstance, as well as from his accounting for the pleasure of poetry on the ground of a natural delight in tracing out resemblances, Aristotle has been sometimes thought to have placed the excellence of a poem in the mechanism of its story,[6] and to have neglected altogether the intrinsic poetry of thought and expression. But we shall not do justice to the comprehensiveness of his views, if we estimate them by the limits of the present work. He seems here to have premised only, what ought naturally to occupy the first place in a philosophical system of the art.

It must be remembered, also, that Greek Poetry was essentially dramatic. It was expressly composed with a view to public recitation or exhibition; and in poetry of this kind, the character of the incidents would hold a much greater importance than in poetry intended chiefly to be read. The incidents would here hold a place analogous to the thoughts and expressions of the poem submitted to the contemplative study of a reader. This may further account for Aristotle's laying so much stress on the interest of the plot in Tragedy

The definition of Tragedy given by Aristotle is remarkable, as savouring more of the spirit of Plato's philosophy than of his own. Describing its nature as it differs from Epic poetry and from Comedy, he further characterizes it as, "by means of pity and fear, accomplishing the purification of such passions."[7] The purification of the soul was the object to which Plato directed the noble enthusiasm of his philosophy. By converse with the ideas of the intellectual world, he would have the soul disenchanted of the spells which bound it to sensible objects, and cleansed of the impurities of its earthly associations. Aristotle's description of the effect designed in tragedy, applies this doctrine to the particular emotions of the soul produced by pity and fear. His idea appears to be, that Tragedy, by presenting the objects of those passions, without the grossness and the violence with which they are attended in actual life, teaches us to feel the passions in that degree only in which an impartial spectator can sympathize with us. By familiarity with these pure abstractions—the true philosophy of the passions so called forth—a moral effect is worked on the heart; the mimic occasions on which it is rightly exercised serving as a real discipline of purification.

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1 The late Bishop Copleston of Llandaff, in his *Defence of the Studies of Oxford*, p. 27.

2 *Rhet. ad Alex.* c. 1.

3 Du Val's *Aristotle*, ii. p. 82.

4 *Poet.* c. 9.

5 *Poetic.* c. 4, 9, 25.

6 *Poetic.* c. 6, αρχη μεν ουν και οἷον ψυχη ὁ μυθος της τραγῳδιας.

7 *Ibid.* c. 6, δἰ ελεου και φοβου περαινουσα την των τοιουτων παθηματων καθαρσιν. So, again, in his *Politics*, viii. 7, he speaks of "purification" as an effect of music. There he promises to explain his meaning when he comes to treat of poetry; but no explanation occurs in the Poetics.

The question, on what the peculiar pleasure of tragic incident depends, is not distinctly considered by Aristotle. But it may be accounted for on his principles; from the view already given of the purification effected by tragedy, and that which he elsewhere gives of pleasure as the result of every affection rightly exerted. That moderation of the passions of pity and fear which tragedy has for its aim, is that due exertion of them to which pleasure has been attached by nature. There is nothing then to disturb or interfere with the pleasurable emotion; as happens when those passions are excited in the real occasions of life.

Practical Philosophy.

Ethics.

It has been already observed, that under the head of Practical Philosophy, Aristotle treats of those sciences which are conversant about the goods of human life. According to this view, the practical sciences are reducible to two: 1. Ethics; by which man is furnished with the principles belonging to his natural good as man; 2. Politics; which inquires into the principles on which the constitution of Societies may be made subservient to the same end. Economics ought perhaps to be stated as a third branch of science under this head. But in the view of Ancient Philosophy, it naturally falls under Politics; inasmuch as it strictly means the regulation of families; the family being considered as the commencement or element of the association of men in cities and states.[1]

In taking a review of Aristotle's Ethical system, it would be injustice to the philosopher to withhold the expression of admiration of the real wisdom displayed by him in this department of science. We are little aware, living as we do in the sunshine of gospel-truth, what a reach of thought it required, in those times, to see the science of Ethics in its proper light, as a discipline of human character in order to human happiness. The ethical writings of Aristotle, composed amidst the darkness of heathen superstition, abound with pure and just sentiments. Instead of depressing man to the standard of the existing depraved opinions and manners, they tend to elevate him to the perfection of his nature. They may indeed be studied, not only as an exercise of the intellect, but as a discipline of improvement of the heart; so much is there in them of sound practical observation on human nature. They are directed, it must be allowed, solely to the improvement of man in this present life. But so just are the principles on which he builds that improvement, that we may readily extend them to those higher views of our nature and condition to which our eyes have been opened. And no greater praise can be given to a work of heathen morality, than to say, as may with truth be said of the Ethical writings of Aristotle, that they contain nothing which a Christian may dispense with, no precept of life which is not an element of the Christian character; and that they only fail in elevating the heart and the mind to objects which it needed Divine Wisdom to reveal.

He has left three principal treatises in this department of philosophy, familiarly known by these names: 1. The *Nicomachean Ethics*, or Ethics addressed to his son Nicomachus, in ten books;[2] 2. *The Magna Moralia*, in two books; 3. *The Eudemian Ethics*, or Ethics addressed to Eudemus, in seven books; besides a short popular tract (probably a summary by another hand), *On the Virtues and Vices*. *The Nicomachean Ethics* exhibits the most formal and complete development of his theory, and is the work on which his fame as a Moral philosopher is chiefly rested. The other treatises are entirely coincident with this in the views taken of the subjects discussed, and often coincident also in whole passages.

It is well known with what eager but unprofitable subtilty the inquiry into the Chief Good was prosecuted by the Greek philosophers. The speculation proceeded from a misapprehension of the nature of Moral Philosophy. They thought, consistently with their method in Physics, that, as every action of human life appeared the pursuit of good, there must be some common principle of good, the constituent of the moral nature of Actions. Again, as the object pursued when attained becomes an end in which the action rests, occasion was given for inquiry into the Ends of actions, and comparing them, and finding out the ultimate End. Hence they were busied in exploring the several objects of human pursuit, and drawing conclusions as to their relative goodness and finality in the order of pursuit. It is easy to see what a field for ingenuity was opened in determining the point where the two notions of the Best and the Final coincided; and in this consisted the determination of the *Summum Bonum*, or Chief Good.

Now Aristotle examined human Actions with a more philosophical eye. He readily saw through the vain realism of those speculations which supposed either some one Idea of Good, or some common quality of good to exist in every thing that was called good.[3] He was aware, also, that when the "ends" of action were spoken of, it was not with reference to some ulterior object, as was implied in all those theories which laid down a speculative definition of the Chief Good; but that it was the very nature of a Moral Action, to be *in itself* an End.[4] Hence he turned aside from that track of inquiry which had misled his predecessors, with the exception of Socrates, and struck out for himself a new path of Moral Science. He has thrown his preliminary views, indeed, into a form resembling that of the speculative moralists, in unconscious deference to the prejudices of the method in which he had been trained. Thus he sets out in his *Nicomachean Ethics* with a sketch of the Chief Good as the final and perfect end of all Actions. And this may give the idea, that in reading this work we are examining a system of the same kind with the Greek Moral Philosophy in general,—a view of it which Cicero[5] appears to have taken; since he speaks of Aristotle's having united two objects as together making up the Chief Good of man. On looking, however, closely into his actual investigation, we find it very different in its pursuit; the agreement being only in the technical form of the argument.

The Chief Good[6] which he is intent on establishing is, the principle or general nature of Actions as such. He investigates, that is, the law according to which Actions attain the good which is their object; and which, as being the *end* really designed in all Actions, whatever may be the immediate particular end sought in each, is the great final cause of all—the End of ends. He speaks of moral virtue as conversant about Affections and Actions, περι παθη και

[1] Theophrastus is probably the author of the first book of the treatise of *Economics*, edited among the works of Aristotle. (Niebuhr's *Hist. of Rome*, Transl. vol. i. p. 15.) The latter part of that book, indeed, does not pretend to be more than a restoration of the Greek text from a Latin translation. The second book is acknowledged to be spurious.

[2] His son Nichomachus has been represented as the author of some of the books of this treatise. Cicero (*De Fin.* v. 5) is inclined to allow him this credit, but without any good reason.

[3] *Eth. Nic.* i. c. 6; *Mag. Mor.* i. c. 1, 2.

[4] *Ibid.* vi. c. 2, 5, x. c. 6; *Polit.* vii. c. 3, 13; Cicero *de Fin.* ii. c. 22, "Id contendimus, ut officii fructus sit ipsum officium."

[5] *De Fin.* ii. c. 6; see also Euseb. *Præp. Evang.* xv. c. 3 and 4.

[6] Laertius mentions, in the Catalogue of Aristotle's writings, a treatise, περι τἀγαθου, in three books.

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πραξεις.[1] In strictness, however, Actions, or Affections as they are exerted in act, are the only proper subject of Ethics; which is conversant about Affections, inasmuch as Affections are implied in Actions. Actions are Affections exerted towards some object, and comprehend, accordingly, both external and internal acts,—as well those which are only known to the conscience of the agent, as those which are open to the observation of men. An action, then, according to Aristotle, is good, in which an Affection attains its object; and, in that case, the Action itself may be regarded as a τελος or End; the Affection being realized, completed, satisfied, in it. Accordingly, it may be inquired, how the Affections really obtain their objects, when exerted towards them, or in action; or what constitutes an Action an End. But this is a very different inquiry from one that, by comparison of particular objects, searches after some definite sole object of pursuit. In this it is presupposed, that every object of a natural Affection is an ultimate end, or an object in which that Affection, whatever it may be, when exerted rests, as in its natural good. It is sought, then, to ascertain how this is so; what that principle is, by which any Action whatever is really a Good in itself and an End. Such a principle is analogous to the Chief Good of the speculative moralists; because it exhibits Actions in that point of view in which their *goodness* consists, or in which they accomplish that good towards which the Affections naturally tend. But it differs, so far as it restricts the notion of the Chief Good to no one distinct class of objects. It is simply a general account of the right constitution of man's moral nature exemplified in the multitude and variety of individual instances of Actions. As Newton does not inquire what Gravity is, but develops the law by which it acts; so Aristotle does not give an abstract notion of the Chief Good, but explores the principle by which it is realized in human life. He thus obtains a view of it independent of any speculative opinions concerning the Chief Good or Happiness of man. His theory leaves the notion of Happiness entirely relative.[2] The philosopher and the uneducated, the rich and the poor, the barbarian and the civilized, each individual, in short, under whatever modifications of human life he may be conceived to exist, must, so far as he obtains the good attached to the exertion of an Affection, or performs a perfect Action, exemplify that law, or ultimate principle, which constitutes an Action a perfect Action, or Good.

His several treatises of Ethics consist of a development of this his characteristic view of human good. He had observed how mankind, through the force of passion and evil habits, mistake and pervert their proper goods. Ethical philosophy, he thought, might be applied to correct this misapprehension of men—to reform this perversion. The force of sound practical instruction, at least, might be tried. He wished therefore to propose to their view the real goods intended for them by the constitution of their nature, and to call the attention of each individual to the pursuit of these in his own particular case. His design throughout accordingly is, to direct the principles of man's moral nature towards their proper objects in such a way that they may rest in these objects as *ends*, and thus attain the proper good of man. When all the principles are so regulated that this effect takes place in each, the collective result is, in such a case, Happiness, or the entire and consummate Good of man. Whence he takes occasion to describe Happiness in general terms, as "Energy of Soul," ψυχης ενεργεια,[3] or "the Powers of the Soul exerted in act" "according to Virtue," or, if there are several virtues, "according to that which is best and most perfect." The mode of description is drawn from his physical philosophy. It is founded on a notion of some intrinsic power in the soul working like the operations of the natural world. His theory of Happiness, then, contemplates this process of the soul at its termination, where the proper nature of the Soul as an *Active Principle* is fully developed. The truth is, we have then a general fact, representing the result in all particular instances in which an Affection is found properly and effectually exerted in act. He takes, indeed, into his estimate of the Chief Good, the effect of the circumstances of the world on the virtuous exercise of the powers of the Soul; adding to his description the condition of "a perfect life,"[4]—or an adequate duration of life, and adequate opportunities,—for the development of the moral principles. This, however, is but to assert, that the law by which man attains the Happiness of his nature, must, in order to be judged of truly, be contemplated in its *tendency*—in the effect that it would realize, if it acted freely, without impediment from the world. To think that external goods are causes of happiness, he says, is like imputing the excellence of the music to the lyre rather than to the art of the musician. Prosperity, he also observes, has its limit in reference to happiness, since it may be *excessive*, and in that case would be an *impediment* to happiness.[5] This necessary qualification of the expression in his sketch of the Chief Good, gives the appearance of his including prosperity to a certain extent as a *constituent* of the Good. Whereas in this point, as well as in the whole form of his inquiry into the Chief Good, he is only following the abstract method of Ancient Philosophy. In reality he is pursuing a course of investigation strictly inductive. The terms themselves, "a perfect life," carry on the idea of the soul's working out its perfection, in which process the perfection of its physical existence would necessarily constitute a part.

Thus, too, the notion of Pleasure, considered as an abstract good, is distinctly examined in his Ethics.[6] The practice of Ancient Philosophy obtruded the question on his notice; whether Pleasure was to be identified with happiness, or was to be regarded as an evil. He accordingly formally discusses it; refuting the existing opinions on the subject, and establishing, that pleasure is a good, so far as it necessarily accompanies the exercise of every natural principle; and consequently, that the highest pleasures are attached to the exercise of the highest principles. The discussion itself is thrown into a form highly abstruse and speculative. But the conclusion at which he arrives is entirely practical, and of the greatest importance in order to a just theory of Virtue. It amounts to this, that the mere gratification of every natural Affection, by its exertion in action, is not to be distinctly proposed and aimed at as the end of that Affection. This would be to grasp at the result, and neglect the means in order to it.[7] For, the gratifica-

[1] *Eth. Nic.* ii. c. 3, 6, 9, &c.

[2] The observations of Paley on "Human Happiness" (*Mor. and Pol. Philosophy*, B. i. ch. 6) are an excellent illustration of Aristotle's Theory,—shewing as they do, that there is no one notion of happiness common to all men and all states of life; and that consequently it is vain to attempt to define the notion of happiness.

[3] *Eth. Nic.* i. 7.

[4] *Ibid.* i. 7, εν βιωτελειῳ; x. 7, λαβουσα μηκος βιου τελειου.

[5] *Ibid.* i. c. 7, vii. 13, x. c. 8; *Eudem.* vi. c. 13; *Polit.* vii. 1 and 13, iv. 11.

[6] *Ibid* vii. c. 11–14, x. c. 1–5, i. 8; *Mag. Mor.* ii. c. 7.

[7] It may be illustrated thus: Suppose, in travelling, some place were pointed out to us in the distance. We may imagine that we shall arrive at it by making it our immediate object, and shaping our course directly towards it. But such a course might lead into insuperable difficulties; whereas by going along the road leading to it, though circuitous and indirect, it will be safely and surely reached.

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tion is, as explained by him, the mere *result* of the adaptation of the affection to its object,—something accruing and *consequent* on the attainment of the object,—not the object itself. It is the completion of the process of nature involved in an Action.[1] The attainment, therefore, of the highest pleasure attached to our nature, presupposes that the perfect work of Virtue has been performed, in adjusting the Moral and Intellectual Principles to their objects.

In proceeding to expand this outline, or "type" as he calls it, of his Ethical system, Aristotle appears to have adopted the language of the Pythagoreans, according to which Virtue was defined a "Disposition or Habitude of Propriety;" or that state of man's moral nature in which all the Affections are in their due measure and proportion. Analyzing the moral principles into, 1. Affections, 2. Powers, and, 3. Dispositions, he rejects the first two classes of principles as inadequate to the production of Virtue; and directs attention to the Dispositions as its proper seat. He observed that the Dispositions were subject to modification by custom or habit,—that a moral character did not precede, but resulted from moral actions; and that a character so formed alone enabled one to act morally. As it was thus evident that virtuous habits were the bond of connexion between virtuous action and virtuous principle in the agent, he concluded, that the principle by which the soul "energized,"—by which its Affections were perfectly exerted in act,—was, in its general nature, a Disposition, or Habitude, influencing the Choice.

He had observed also, that in every instance in which Good resulted from the exercise of the Affections, due regard was had to the person of the Agent, to the occasion, to the matter in hand, to the persons respected in the action, to the purpose, &c.; that thus, the virtuous character consisted in its power of due adjustment to all the circumstances of the case in every action. On the ground, then, of this general fact, he further concluded the nature of Virtue to consist "in a *mean* relatively to ourselves,"—relatively, that is, to the individual agent in each instance.[2] The abstract mode of expression is a continuation of the same physical notion under which his theory of the Chief Good is represented. The soul, when truly virtuous, is conceived to be wrought to a temperament or mean state, all its Affections and Actions being in their due proportions to one another, and to the whole nature and circumstances of the individual man.

To determine, however, this due measure of the Affections, is the great question of Ethics. An exercise of Reason is implied in the adjustment of the Affections and Actions, so as neither to exceed nor fall short of the due measure on each occasion, and of that particular function indeed of Reason which is conversant about the affairs of human life, and which we call Prudence. Aristotle, accordingly, includes in his outline of Virtue, the statement that "the mean" must be "defined by Reason, and as the prudent man would define it." Still the question remains, what is the standard of adjustment —what the criterion of the mean, as a mark to which the moral aim is to be directed?

Now, the instances in which this self-moderation belonging to the character of virtue is observed, become in themselves the objects of Approbation, exciting in us sentiments of love, esteem, admiration, honour, sympathy, &c. Hence the various expressions introduced into Moral Philosophy, of fitness, propriety, proportion, the decent, the fair, the honourable, the amiable, the expedient, &c.; the adoption of one or more of which tests of the morality of Actions, has given its peculiar complexion to different systems. Aristotle contemplates these sentiments of Approbation, not as they are in themselves, but as they are outwardly evidenced by the Praise accompanying certain Actions.[3] It is clear that men commonly praise some actions and censure others. Where men—not any particular class of men, but society at large—agree in praising any action,[4] there the action so commended may be regarded as good in itself, and an evidence of virtuous principle in the agent. The approbation thus signified was expressed in the Greek language by the term καλον,[5] to which we have no perfect counterpart in our language, though the word "honourable" if understood in its full meaning, may sufficiently represent it.

Aristotle proceeds to apply this criterion to the discrimination of the several virtues; a distinct class of objects of the Affections constituting in his system the ground of a distinct virtue.

His enumeration of the virtues is incomplete. It is, however, chiefly intended as an evidence by induction, of that moderation of the affections—"the mean"—in which the nature of Virtue consists. His division, indeed, of Virtue is physical rather than logical—an enumeration of the *parts* of virtue rather than of the *kinds* of it. His method, accordingly, did not require of him a complete statement of all the particulars comprised under the general term Virtue. He has been accused of attending chiefly to the splendid virtues. He was probably led, by the very criterion which he employed, as well as by his view of the connection between Ethics and Politics, to sketch more prominently those particular virtues which recommend a man in society. And thus he has sketched beautiful outlines of those charms of familiar intercourse—affability, frankness, agreeableness.[6] His introduction, indeed, of these qualities among the virtues of his system, is a striking evidence of the practical nature of that virtue which he inculcates. It is a virtue which is not to be forgotten in any part of a man's daily life. Whilst it nerves his arm in dangers, distributes his bounty, shields him against temptations of pleasure,—it unbends him in the hours of leisure, and is ever on his tongue, whether gravely pronouncing in his assertions and judgments, or playing in the sallies of his wit. These very instances shew that he did not regard splendour as the exclusive attribute of virtue. On the contrary, he expressly speaks of it as the heightening and decoration of the several virtues, and as excellent because it presupposes all other virtues in their perfection.[7] Another evidence of his not being exclusive in his regard to the more showy virtues, is his treating of Gentleness.[8]

He selects the virtue of Justice[9] for more particular discussion. He distinguishes it as a particular virtue from the whole of Virtue, which it denotes *relatively*,—in its being the moderation of the love of gain or self-interest. Seduced, however, by the example of Plato, he departs, in his mode of treating this virtue, from the strict province of Ethics into that of Politics. The Justice which he explains is a political virtue, applicable to the citizens of a common state, rather than to man as man. And this confusion of ethical and political justice has led him into a speculative refinement, which

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[1] Pleasure, accordingly, is defined by Aristotle, in his *Rhetoric*, i. 11, physically, as "a kind of motion of the soul, and a full and perceptible constitution into the proper nature."

[2] *Eth. Nic.* ii. 6, ἑξις προαιρετικη, εν μεσοτητι ουσα τη προς ἡμας.

[3] *Ibid.* i. cap. ult., ii. cap. 5, 8, 7; *De Virt. et Vit.* p. 291.

[4] *Ibid.* x. cap. 2, ὁ γαρ πασι δοκει, τουτο ειναι φαμεν.

[5] *Ethic.* passim; *Rhet.* i. cap. 9.

[6] *Eth. Nic.* iv. cap. 6, 7, 8.

[7] *Ibid.* iv. cap. 3, ἐοικε μεν ουν ἡ μεγαλοψυχια. οἱον κοσμος τις ειναι των αρετων μειζους γαρ αυτας ποιει, και ου γινεται ανευ εκεινων· δια τουτο χαλεπον τῃ αληθειᾳ μεγαλοψυχον ειναι ου γαρ οἱον τε ανευ καλοκἀγαθιας.

[8] *Ibid.* iv. cap. 5.

[9] Among his lost treatises was one *on Justice*, in four books. (Diog. Laert.)

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involves a difficulty in reconciling the notion of Justice with his theory of Virtue. Looking at Justice as a dispensing power, he observed that it was concerned about "a mean," in things themselves, in apportioning to each person his exact due, whether of reward or punishment. On the ground of this fact he points out that Justice is not "a mean," as the other virtues are, but is "of the mean"—not in itself "a relative mean," but "relative to a mean." Had he considered Justice solely as a moral habit; he would have seen that the distinction was unnecessary: since in this point of view it conforms precisely to his general notion of virtue in being a principle of self-moderation. There is, however, a foundation for the remark in the circumstance, that Justice admits of greater exactness in its exercise than other virtues. "The rules of Justice," says an excellent writer,[1] "may be compared to the rules of Grammar; the rules of the other virtues to the rules which critics lay down for the attainment of what is sublime and elegant in composition." In the other virtues we are thrown more on our sense of propriety in forming our practical decisions. In justice we have evident facts before us—the merit or demerit of individuals in themselves; and these form an external standard to guide us in our conduct, over and above our internal convictions of right. So far, then, Justice may be regarded as "of the mean," besides being also a point of propriety, or a mean within ourselves. Aristotle, it should be observed, had no other more appropriate word distinct from "Justice" to express "honesty" or "integrity," and consequently was led to generalize too far in his analysis of Justice.

Aristotle's discussion of Friendship[2] is open to similar objection. He has considered it in its outward effects as a social principle akin to Justice—to which Justice is subordinate and supplementary—rather than as an internal ethical principle, the moderated exercise of benevolence in the heart itself. His observations, however, on the subject admirably illustrate the importance of Friendship to the right constitution of society—the various modifications of the benevolent principle in the different relations of human life—together with the peculiar amiableness of virtue in itself. In the last respect, indeed, the discussion forms an essential part of his Moral Philosophy, as it tends to show his conviction that the moral principles have their seat in the heart.

Indeed, this part of his Ethics, as well as his inquiry into Justice, should be accurately studied by all who would obtain just views of the comprehensive character of the Virtue of his system. Together they comprise a body of relative duties. Under Justice would be classed the duties of "religion, memory of the dead, filial reverence, patriotism, civil obedience, veracity, honesty," &c.,[3] so far as these duties flow from *claims* on our respect, and are prescribed by human laws; under Friendship, the same duties as they are prompted by sentiment and feeling, and are known by the names of piety, gratitude, benevolence, fidelity, generosity, &c. Hence the character of Virtue, in the little compilation on the Virtues and Vices which passes among his works; that "it is of Virtue both to benefit the worthy and to love the good; and to be neither apt to punish nor revengeful, but merciful, and placable, and indulgent: and thus there follow on Virtue, kindness, equity, candour, good hope; moreover, such qualities as, to be domestic, friendly, social, hospitable, philanthropic, and a lover of what is honourable."[4]

His theory, then, of Virtue must be regarded as involving a minute and distinct attention to all the particular virtues. And herein appears its great excellence, as contrasted with those of some modern philosophers, who have endeavoured to trace up all the virtues to some one principle of our nature, as benevolence, or self-love, or prudence. All such theories are in truth mere accommodations of language, by which different classes of phenomena are arranged under the same terms; the effect of which is to give a shadowiness to the form of virtue, instead of striking it out in distinct outline. Aristotle's theory is the law by which these different principles are held together in fact—the common process by which the operation of each virtue is carried on; and which, when realized in the character of a man, gives him the command of all the virtues.

The ancient Moral Philosophy sought, like the Modern, to resolve Virtue into some *one* principle. But the endeavour of the ancients was chiefly to ground it on some *Intellectual* principle. Socrates contended that the virtues were instances of Prudence or Knowledge, *φρονησεις*, or *λογοι*, or *επιστημαι*. Aristotle shews the foundation of this misconception, in explaining in what respect the production of virtue might be regarded as the work of the intellect. Each virtue consisting, as he shews, in the adjustment of the action to all the circumstances of the case, the virtue of an action must depend on the practical judgment of the individual agent; and an agent who is uniformly virtuous must exhibit this practical judgment uniformly operating, enabling him readily to decide on the point in which the virtue of acting lies.[5] This operation of the intellect on moral objects he designates as the intellectual virtue of Prudence or Wisdom.[6] When he speaks of it as "defining" or bounding the mean in which virtue consists;[7] he implies that, as a speculative definition presents to the mind an exact notion of the thing defined, so the principles supplied by Prudence give clear perceptions of the moral nature of an Action. For example, suppose a man to have received some evident wrong—some injury done to him without provocation. The Affection of Resentment naturally leads him to requite the injustice on his assailant. But by what method of action he should do so, is a matter of question. He must know exactly in what way his Resentment should be shewn, in order to act virtuously; besides having, as his general principle, the inclination to act virtuously.[8] He must, therefore, have had some experience of human life—some practical knowledge of the nature of Actions which have been generally approved as fulfilling the end of this Affection. An experience, then, of this kind, applied to the exercise of all the Affections, and operating invariably on the conduct, constitutes the Prudence of Aristotle's system. It is thus intimately connected with the moral principles, as the moral principles are with it. It is the combined result, in the intellectual part of our nature, of all the virtues of the heart; as, on the other hand, Prudence is the diverging of the intellect through the various virtues of the heart. Hence his conclusion, that it is impossible to be properly good—*κυριως αγαθον*—without Prudence; or to be prudent without moral Virtue; and consequently, that all the Moral virtues are inseparable, inasmuch as the possession of all is requisite for the perfecting of Prudence,[9] and with Prudence they all follow.

In this account of Prudence is to be traced the principle of Moral Obligation involved in Aristotle's theory of Virtue. He considers the Moral virtues as those of the inferior part of the soul, and therefore as formed to obey; whereas the intellectual principles, as being purely rational, have, as such, an intrinsic authority. Prudence, accordingly, being the intellectual virtue employed in conjunction with the

[1] Adam Smith, *Theor. of Mor. Sentim.* part iii. chap. 6.
[2] *Eth. Nic.* viii. ix.
[3] *De Virtut. et Vit.*
[4] *De Virt. et Vit.* p. 296, Du Val.
[5] *Polit.* vii. 13.
[6] Σοφια means Philosophy rather than what we understand by wisdom.
[7] *Eth. Nic.* ii. 6, ὡρισμενῃ λογῳ. και ὡς αν ὁ φρονιμος ὁρισειε.
[8] *Mag. Mor.* ii. c. 7; *Eth. Nic.*
[9] *Eth. Nic.* vi. c. 13, x. c. 8; *Eud.* v. c. 12.

moral in the production of Virtue, is, from its nature, supreme over its associated principles, and demands of right their submission to its dictates.[1] It must be confessed that such a ground of obligation is merely theoretic; and so Aristotle himself perceived it to be.[2] As a principle of observation and reflection, it resembles in some measure the supremacy of Conscience; but it does not come up to the force of that master-principle. Conscience rewards and punishes by its judgments, carrying with it a sense of merit and demerit; whereas the dictates of prudence carry no such sanction in them. Properly, however, the notion of "Obligation" is inapplicable to his system. Not inculcating Morality as a law, but as a philosophy, or art of life, he was not called upon to shew why it should be obeyed as a law. It was enough for him to point out, from observations on human conduct, that it is in fact obeyed by all who attain their real good.

But though the principle of Conscience has no place in his theory, it is certainly implied in his test of virtue and vice—the praise and blame of mankind. The universal consent of mankind on these points he regards as decisive of the Moral nature of an Action. But this is to allow a standard of right and wrong inherent in human nature, or what is equivalent to a Conscience. If all agree in praising a certain modification of the Affections, and in blaming another, it is clear that there must be some common principles in all to serve as the bases of these unanimous judgments. The same conclusion results from his admission of Dispositions or Capacities of virtue, and of the existence of natural virtue, in man, antecedent to the proper formation of it in the character. Indeed, his analysis of Prudence is decisive of his real view of this point. Not only are the principles on which Prudence is to speculate to be drawn from the heart; but the very deduction of these principles to the particular cases of conduct involves moral perceptions. For how else is the precise point in which the "mean" lies—in which the due measure of the Affection exerted consists—to be ascertained? If the virtue of the Action consisted in an absolute mean, a mere intellectual process, such as that of Arithmetic or Geometry, might ascertain it. But the mean in question being neither more nor less than what is *proper*, this implies a sense of propriety. Right conduct, according to him, is not such because it is neither excessive nor defective; but is neither excessive nor defective because it is right. This is plain from his induction of the several virtues, in which he shews that there is a "mean," because there is a point of propriety; so that a Moral perception must precede every decision on Moral questions. It is of the greatest consequence, in order to a right understanding of his account of Virtue, to observe this necessary dependence of the knowledge of the "mean," on the adjustment of the moral principles to their objects. The want of attention to it has led to absurd objections against Aristotle's theory. He has been interpreted, as if he had said that we could have *too much* courage, *too much* liberality, &c.; which notion proceeds on the false assumption, that the mean laid down by Aristotle is a *quantity;* whereas it is only a proportion or correspondence existing between the principles of the agent and the objects of those principles.[3] The term "mean," in fact, as employed by Aristotle, is merely negative, marking the exclusion of all unchastened, inordinate, or undue feeling from the character of Virtue.

But though his system is defective as an authoritative law, it develops a much nobler theory of duty than the philosophy which rests our obligation to virtue on a ground of interest. The "Prudence" of Aristotle's Ethics must be understood as widely different from the prudence of such a theory. The Prudence which he teaches is no calculation of consequences. It is a practical philosophy of the heart; inseparably connected with the love of that conduct which it suggests. Whereas, when we are taught to act on the ground of interest, the prudence then inculcated is a mere intellectual foresight of consequences, independent of any exercise of the heart.[4] Such a system, whilst it overthrows the distinction between right and wrong as a fundamental principle, requires either a very comprehensive power of intellect in order to its practical adoption, or an express revelation from the Deity, declaring the good and evil consequences annexed to particular actions. These are conditions which sufficiently expose its futility as a sole guide to duty. The heart of man leaves far behind this morality of consequences, and decides, even before the action itself has its birth, whether it is morally right or wrong. The appeal to the revealed will of the Deity is not only a *petitio principii*, inasmuch as no will of the Deity can be ascertained and proved divine, without the previous admission of principles of right and wrong; but is refuted by the simple fact, that theories of Virtue, such as that of Aristotle, have been devised by men who had no positive belief in a Divine Providence. Independently of the excellence of such theories, the mere fact of their *existence* as accounts of Human Duties is sufficient for the argument. That "the difference, and the only difference," between an act of prudence and an act of duty is, "that, in the one case, we consider what we shall gain or lose in the present world—in the other case, we consider also what we shall gain or lose in the world to come;"[5] —is an assertion, disproved at once by the fact, that Aristotle saw a difference between the two acts, independently of that consideration on which the notion of duty is there made to rest. Whether he has stated the difference correctly or not, is immaterial to this point.

The principle of Self-love has also been well illustrated by Aristotle in its relation to Virtue. He distinguishes between the culpable form of it, or selfishness, and that form of it which is auxiliary to virtue. Self-love, then, in its good sense, may be acted on by the virtuous man, whose character is already framed on the principle of "the honourable;" and in that case, he shews, it will be coincident with Benevolence; since the person so pursuing his own interest will also effectually promote that of others. But this is not the case with the bad man; since, in pursuit of his views of self-interest, the bad man will at once injure himself and others by compliance with bad passions.[6] It is further evident from the above, that he does not admit of Benevolence being made a principle of conduct, otherwise than as it presupposes other moral principles, and is regulated consequently in its exercise by a prevailing regard to the "honourable" or right. He has also enforced his primary notions of Duty by pointing out the proper amiableness of virtue, both as the only sure tie of attachment between man and man,[7] and as the only thing which produces tranquillity, self-satisfaction, and delight, in a man's own bosom. On the latter point, indeed, he speaks almost in terms descriptive of the joys and pangs of Conscience.[8] So justly has he embraced in his view the most powerful auxiliary principles, without exalting them,

[1] *Eth. Nic.* i. c. 13, iii. c. 12; *Polit.* viii. c. 14.

[2] *Eth. Nic.* x. c. 9.

[3] *Eudem.* iii. cap. 7; *Eth. Nic.* ii. cap. 6, ὁ μητε πλεοναζει, μητε ελλειπει, του δεοντος—στοχαστικη γε ουσα του μεσου.

[4] A moral philosophy of this kind is in fact a revival in a new form of the theory of Socrates, which made virtue a science. It overlooks the affections in the production of virtue, as the theory of Socrates did.

[5] Paley's *Mor. and Pol. Philos.* book ii. chap. 3.

[6] *Eth. Nic.* vol. ix. cap. 8; *Mag. Mor.* ii. 13, 14; *Polit.* ii. 3.

[7] See Bishop Butler, *Serm.* i.

[8] *Eth. Nic.* ix. cap. 4, Ει δη το οὑτως εχειν λιαν εστιν αθλιον, φευκτεον την μοχθηριαν διατεταμενως, και πειρατεον επιεικη ειναι· οὑτω γαρ και προς αὑτον φιλικως αν εχοι και ἑτερῳ φιλος γενοιτο. *Eudem.* vii. cap. 6.

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as some philosophers have done, to an undue place, by making the Theory of Virtue to rest on them.

Such, then, is that account of Virtue which Aristotle's Practical Philosophy develops. He delivers it as the theory of perfect conduct—as that, which is exemplified in operation whenever human good is realized in life. It is at the same time, it should be observed, both an account of the Nature of Virtue, and of the internal process of Man's Constitution by which Virtue is produced. The affections being all habitually moderated by Prudence, Virtue is the result; and in that Moderation consists the Nature of Virtue.

He was not, however, inattentive to the fact, that the speculative perfection of a practical rule is not realized in Human Life. He was aware that a complete subordination of the Affections to the principle of Prudence was a task of difficulty above the efforts of Man as he is. So also his view of Vice, as that state of man in which his principles are entirely corrupted,[1]—the affections being conformed to evil, so that he continually and insensibly[2] chooses evil rather than good,[3]—is a philosophical limit of the extent of human depravity, and not an account of Vice as it actually exists in the world.[4] It is indeed a just conclusion, from experience of that degradation to which our nature is brought—the hardening of the heart, as the Scripture terms it, by the habitual violation of duty. As the end, therefore,—as the perfect form of vice,—this state of the heart demands to be sketched out by the moralist, to give the full truth and cogency to his admonitions. His outlines of virtue must be drawn from Virtue realized in its tendency—from that condition of it in which it is the attainment of man's Chief Good; as Vice, on the other hand, must be contemplated where it stands fully confessed as man's Chief Evil. There may be a virtue above Man's nature, as there may be a vice below it; and Aristotle notices both these extremes. But neither of these presents a standard of human excellence or human depravity, and therefore requires no distinct consideration in an Ethical treatise. The actual virtues, however, and vices of men, as they are observed in the world, exhibit an endless variety of modifications within the theoretic limits of Virtue and Vice. The Affections are more or less brought into subjection to the rational principle in different individuals; and men are praised and blamed in proportion as they have established this command over themselves, or have impaired and lost it. Hence a secondary or inferior kind of virtue results, as well as a less odious vice. As it is in the indulgence of the sensual affections that human frailty is most seen, Aristotle distinguishes this secondary virtue and vice by contrast with the particular virtue and vice of Temperance and Intemperance; as if they were simply what we express by Continence and Incontinence. But his distinction of their nature is a general one, and belongs to the whole character of Virtue and Vice.[5] But in admitting a morality of this nature, he laboured under a speculative difficulty. Socrates had denied the existence of any such imperfect vice, on the ground, that the virtues were sciences; and that it was impossible for a man to act against his knowledge of the best. Aristotle, who, though not agreeing with Socrates in regarding the virtues as sciences,[6] still admitted an intellectual process in the production of Virtue, felt himself required to explain how this higher principle was ever overpowered by the weaker, as it is in the incontinent man. In the course of this explanation, he has touched on the true philosophy of those facts in which the principles and practice of men are evidenced at variance. He has accounted in some measure for the apparent anomaly of the same person exhibiting such contrasts of character—at one time commanding the passions, at another yielding to them. For he delineates, it should be observed, under the characters of "the continent" and "incontinent," not two different persons, as in the case of "the temperate" and "intemperate," but what will usually be the same person at alternate intervals; since no one can very long remain either. For by the one course continued long, and the habit consequently formed, a person will become the "temperate" man, by the other the "intemperate."

The question of the freedom of the Will has been admirably treated by Aristotle. It is discussed as it ought to be in a treatise of Moral Philosophy, independently of those metaphysical difficulties with which it is commonly overlaid. What the nature of human Will is, whether free or necessary, according to our abstract notions of liberty or necessity, forms no part of his inquiry. He points out simply, what are the classes of actions in which an agent is generally held *not* responsible for his conduct; and excluding these, decides on the remainder—that, since in these, men *are* held responsible (as is shewn by the praise and blame, reward and punishment, attaching to their conduct), the actions are voluntary. This is the extent to which the inquiry, so far as it is strictly ethical, ought to be carried. Whether we speculatively conclude the Will of man to be free or necessary, *practically* we must regard it as free. For to act on that supposition accords with the facts of human life: whereas, to act on the theory that we are under a necessity, would lead us against the practice of mankind, which treats persons as responsible for their actions. Aristotle indeed argues, that though the question be decided in the negative, it leaves the relative nature of virtue and vice on the same footing. If their virtues may still be imputed to men, so may their vices.[7] But he more distinctly affirms the *voluntary* nature both of virtue and vice, on the ground that the αρχη, the principle of the action, is εφ' ἡμιν—in ourselves—in our own power. Thus, though the virtuous or vicious habits that men have formed may dispose them to a particular course of behaviour, so that, *as under their influence*, they cannot act otherwise, yet the actions so performed are voluntary; because it was in their power to pursue or forbear from that course of conduct which led to the settled habit, and to the corruption of their moral principles.

The principle thus described as "in ourselves," is, in Aristotle's Philosophy, the Motive of action. It is that from which the *effect* in the conduct originates; and it comes, therefore, under that class of principles, which constitute the Motive or Efficient Cause. The term, Motive, however, is popularly applied to the *object* or *end* of an Action,[8] which being something external to ourselves, or at least capable of being so viewed, gives occasion to question the voluntary nature of Actions. An aim, indeed, at a particular end is

[1] *Eth. Nic.* vii. cap. 8, Ἡ γαρ αρετη και μοχθηρια την αρχην, ἡ μεν φθειρει, ἡ δε σωζει; vi. 5, Εστι γαρ ἡ κακια φθαρτικη αρχης.

[2] *Ibid.* vii. cap. 9, ἡ μεν γαρ κακια λανθανει. *Rhet.* ii. 4, τα δε μαλιστα κακα, ἡκιστα, αισθητα, αδικια και αφροσυνη. This insensibility is the result of confirmed habit; and the same result takes place in regard to virtue. The moral principles are less felt, as mere internal principles, when perfected in the character; operating as it were without thought or effort, in the conduct. See Bishop Butler's *Analogy*, chapter on Moral Discipline.

[3] *Ibid.* vii. cap. 8, Ὁτι μεν ουν κακια ἡ ακρασια ουκ εστι, φανερον· αλλα πη ισως· το μεν γαρ παρα προαιρεσιν, το δε κατα προαιρεσιν εστιν.

[4] *Ibid.* iv. cap. 5, Ου μην ἁπαντα γε τῳ αυτῳ ὑπαρχει· ου γαρ αν δυναιτο ειναι· το γαρ κακον και αὑτο απολλυσι, καν ὁλοκληρον ᾐ, αφορητον γινεται.

[5] *Ibid.* vii. c. 7; *Eudem.* vi.; *Eudem.* iii. c. 11.

[6] *Eudem.* vii. c. 13; *Eth. Nic.* vii. c. 3.

[7] *Ibid.* iii. c. 1, 5; which is in substance the conclusion of Bishop Butler (*Anal.* p. 1. chap. on the *Opinion of Necessity*). The whole doctrine of this chapter is coincident with the views of Aristotle, and illustrative of them.

[8] Paley speaks of "private happiness" as "a motive." (*Mor. and Pol. Phil.* b. ii. c. 3.) We use the term correctly when we say that ambition or avarice is a person's motive, but not in saying that power, or interest, or happiness, is so; for these are ends.

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implied in every Action; and on the End sought depends the morality or immorality of the Action. But, in strictness, it is the Choice alone that moves the agent.[1]

But the principles employed in the production of Moral virtue are not the whole of our internal nature, nor are they the highest principles. And Aristotle's theory implies the exertion of all; and further, if there be a relative superiority among them, a preference of the higher. The moral virtues, according to the theory of Plato which he adopted, having their seat in that part of the soul which was termed irrational, —or only rational as it was capable of obedience to Reason, —were the virtues of the inferior part. Accordingly, the greatest Happiness must result from the exertion of the Intellectual principles. Analyzing these into the five heads of, 1. Science, or the knowledge of Demonstrative Necessary Truth; 2. Art, or the knowledge of Contingent Truth in the operations of man; 3. Prudence, or the knowledge of Contingent Truth in the conduct of Life; 4. Intelligence, or the knowledge of First Principles; 5. Wisdom or Philosophy; he assigns the pre-eminence to the last, as the perfect combination of Science and Intelligence, and as having for its objects the highest natures.

That a philosopher, living amidst the disorder and misery occasioned by the want of true Religion, should have sought for a perfection of happiness out of the troubled scene in which moral virtue is disciplined, cannot excite our wonder. The calm regions of philosophical contemplation —*sapientum templa serena*—presented a natural refuge to the anxious mind, eager to realize its own abstractions in some perfect form of human life. It was a search, indeed, after that happiness which Revelation has made known to man—a happiness out of his present sphere of exertion and duty, where he might obtain the full end, or consummate good, of his being. Aristotle accordingly describes the pursuit of *this* ulterior happiness, as the "immortalizing" of our nature; as the living according to what is divine in man; as what renders a man most dear to the Divinity, most godlike.[2] Not attributing, however, any real immortality to the nature of man, he could only draw his notion of perfect happiness from a view of the present life.[3] In this view, the Intellectual virtues are undoubtedly entitled to the preference; though experience must have convinced him, that even these are not without their alloy.[4] He by no means, however, regards the exercise of the Intellectual virtues as an exemption from the necessity of cultivating the Moral. The happiness of the Theoretic life is the highest privilege of man's nature. Still the practice of the Moral virtues is enjoined, that each person may perform his part as a man living amongst men. No philosophy but that of Aristotle has so justly maintained this proposition. Plato would lead his followers into the indolent reveries of mysticism; the Stoics would reduce theirs to indifference about human things; the Epicureans would absorb theirs in the fulness of present delights; Cicero would degrade the higher functions of the contemplative life below the ordinary moral duties, confounding the dignity and the indispensableness of an employment. But Aristotle elevates the aim of man to that happiness which, as purely intellectual, is inadequate to the wants of a nature consisting of body and soul; whilst he calls him also to the strenuous discharge of the duties belonging to that compound nature, and to his actual condition in the world.

Politics.

The experienced inefficiency of ethical precepts in themselves to produce morality in the lives of men, and the consequent appeal to some external sanction for their enforcement, led to such works among the ancients as the Politics of Aristotle. The Christian observes the same fact, and draws from it a strong argument for the necessity of a Divine Revelation. Aristotle and other Greek philosophers looked to the influence of Education directed by civil laws and institutions, and to the rewards and punishments of civil government, as the great instruments for bringing mankind to that course of action in which their real interest consisted.

In ascribing this moral force to the law of the state, Aristotle adopted the current notion of Ancient Philosophy, which confounded moral and political good. The good of man as an individual was conceived perfectly coincident with his good as a citizen; and the science of Politics, therefore, was treated as including under it that of Ethics. Had not philosophers been misled by their extreme pursuit of abstract speculation, they could hardly have thus blended together the distinct objects of moral and political science in one common theory. They would have seen that the social union could only indirectly promote that good of man which belongs to his internal nature; that it could reach no further than to the protection of the individual from external aggression on his person and property, and allowing him the unobstructed exercise of his virtue. "Civil government," says Bishop Butler, "can by no means take cognizance of every work which is good or evil; many things are done in secret, the authors unknown to it, and often the things themselves; then it cannot so much consider actions under the view of their being *morally* good or evil, as under the view of their being mischievous or beneficial to society; nor can it in any wise execute *judgment* in rewarding what is *good*, as it can, and ought, and does, in punishing what is *evil*."

In consequence of this misapprehension of the end of the social union, the Political philosophy of Greece was not a system of jurisprudence, nor any discussion of questions affecting the policy of particular states. It was a speculation concerning the Perfect Polity—a theory of social happiness considered as the result of positive institutions and laws. Ingenious men amused themselves with fancying how society might be modelled, so as to exhibit an ideal optimism; instead of attending to the real phenomena of human life, and deducing from them the right administration of Society under its existing forms.[5]

Aristotle, accordingly, constructed a theory of Politics on this delusive principle. Proposing to himself the Perfect Polity, as that in which the virtue and happiness of the man and the citizen exactly coincide, he proceeds to sketch out the form of it, and thus to obtain an outline of the institutions on which his ethical system must depend for its support. But he was not so fascinated by the theory on which he worked, as to overlook the practical nature of the science. He complains of his predecessors, that however well they might have treated the subject in other respects, they had at least failed in the useful. They had contented themselves with devising forms of polity which could only be realized with a concurrence of every favourable circumstance: whereas the usefulness of the science required the delivery of principles such as were practicable in existing cases. We know, indeed, from the titles of other works on Politics which he is said to have written, *The Polities of One Hundred and Fifty-eight States*, four books *On Laws*, and two books *On the Political Man*,[6] that he did not consider the subject as exhausted in the theory of a perfect polity. The observations, too, on Justice and on Civil

[1] *Eth. Nic.* vi. c. 2; *Eudem.* ii. c. 11; *Metaph.* vi. c. 1.

[2] *Eth. Nic.* x. c. 7 and 8.

[3] *Ibid.* x. c. 8, αἱ δε του συνθετου αρεται ανθρωπικαι, κ. τ. λ.

[4] See Bishop Butler's Sermon *On the Ignorance of Man.*

[5] Draco, however, and Pittacus, were only framers of laws, and not of polities. (Aristot. *Polit.* ii. c. *ult.*)

[6] These works are mentioned by Diogenes Laertius. A portion of the *Polities of One Hundred and Fifty-eight States*, relating to the constitution of Athens, has been preserved by Julius Pollux.

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Policy, contained in his Ethics and Rhetoric, are proofs of the sound practical views with which he contemplated the subject. And even in the work now before us, which develops his professed theory of Politics, the substance of the inquiry is, judicious and enlightened instructions of policy, drawn from experience of human nature, and applicable to all times and circumstances. From its connection with his Ethics, it was intended, probably, to be applied by each individual in the practical business of Education. He wished the student to obtain that scientific knowledge of the effects of institution and discipline on the human character, which might assist him in the treatment of the particular cases of his own experience.[1] It thus harmonized completely with his Ethics; the object of which was, as has been shewn, to enable each man to attain his own particular good by a general knowledge of the real good of man.

The perfect polity sketched by Aristotle is a theory of the end to which man, viewed in his social capacity, at its best estate, and unimpeded by external obstacles, may be conceived to tend. It is a view of the End or τελος in his Political system, corresponding to his account of the Chief Good in his Ethics. He arrives at it by the same train of thought which led him to his account of the Chief Good. He considers, first, that man, independently of any calculations of expediency, is naturally a political being;[2] as in his Ethics he assumes that man is endued by nature with active principles tending to his own good. He admits that Expediency is instrumental in cementing the union among men, but does not rest society on this principle; wisely judging that man is induced originally to associate with man by various internal principles of his nature, and not simply by motives derived from reflection on his wants. Such motives are in truth only secondary causes, and auxiliary to the former; in like manner as the principle of self-love is auxiliary to the natural affections on which virtue is founded. As, then, in his Ethics, he went on to inquire what principle rendered actions perfect, exhibiting them as attaining the end for which Nature had constituted the Affections; and as this principle formed the Chief Good of his Ethical system; so in his Politics, he carries on his view of the social nature of man to the point where the union to which it tends appears self-sufficient and perfect. The mode in which the social principles might be found to operate in this ultimate case would present the perfection of Social Virtue. And from this specimen of Social Virtue would be deducible right forms of government, institutions, and laws, just as the rules of right moral conduct are drawn from the whole moral nature of man contemplated in its perfection.

To put ourselves, accordingly, into that posture of mind in which Aristotle contemplated the subject, we must suppose the case of a Society analogous to that of an individual. The analogy between the principles of the heart, as a constitution, or system of related principles tending to a common end, and the elements of a political community, could not but be familiar to the mind of a disciple of Plato, who delighted in drawing his outlines of moral virtue from the imagery of social life. But Aristotle, though sometimes imitating the beautiful language of Plato in his ethical descriptions, has inverted the analogy, and framed his representation of a perfect society after the resemblance of the internal constitution of the heart. We must imagine, then, the various members of a community, when brought to the standard of perfection implied in the notion of a Perfect Constitution, all obtaining their respective dues, in a manner analogous to the due moderation of the affections in the virtuous character. A "mean" is to be attained in the one case as in the other.

Agreeably to this view of his mode of speculation on the subject, he describes the Perfect Polity as a mixture of Oligarchy and Democracy—as a state which appears to be both these forms of government, and yet neither of them; in which, no one of the component elements of Society has preponderance, but the claims of freedom, of wealth, and of virtue,[3] are all duly considered. A form of government which is thus a "mean" throughout, he designates by the name of "Polity" or commonwealth; appropriating to it the general name, and thus distinguishing it as the perfect form, the proper constitution of a πολις, a City or State;—a city or state being the "end" of the Social union.

If, indeed, the promotion of virtue, were the direct and proper object of the Social union, as Aristotle conceives, it must be allowed, that that only can be a perfect constitution of Society, in which the standard of political rights is the same with that of moral right. In this ultimate perfect form, upon such a supposition, the science of Politics becomes absorbed in that of Ethics. The community in this case acts as the dispenser of the laws of morality; and its honours and its penalties are but the channels through which virtue works its own rewards of happiness, and vice its own punishments of misery.[4] But this is, as was before observed, to intrude on a province far beyond that of political science. Schemes for the moral perfection of Society belong to the wisdom of a Providence more than human, working good out of evil, and, from a boundless survey of all the relations of things, accomplishing important results by means apparently incompetent or even adverse. Man, in his designs of moral good, has only to attend closely to the mechanism placed under his observation—to use the appointed means—to cultivate given powers—to provide against foreseen consequences;—and then, having done his part, to trust that the happiness, which must surely be the end of the whole under a wise and good Providence, will be the final result of his well-ordered exertions. Thus, it is manifest to our view, that from the ungoverned passions of men evil will ensue. Society, therefore, may lawfully be employed as an instrument for preventing this misery, so far as external means can reach it; and so far, too, it may encourage virtue, and indirectly promote human happiness.[5] But let it propose to itself "what is best" as the distinct aim of its constitution; and it bewilders itself with theories, no one of which will probably realize the expectations conceived of it; whilst, on the contrary, some evil must certainly ensue from artificial attempts on so large a scale. For it is impossible, as Aristotle himself observes, but that, "from false good in the outset, real evil must at length result."[6] He is quite consistent here, however, with the rest of his philosophy. Excluding from the course of nature a Providence distinct from Nature itself, he proceeded, according to his system, to attribute an internal self-adjusting power to Society considered as a work of Nature. The maxim, that "Nature does nothing in vain," is at the base of his moral and political philosophy, as well as of his physical. The perfect polity is an illustration of this maxim. It is the perfecting of the self-provisions of Nature in man considered as a social being.

The real excellence, however, of Aristotle's theory of the Perfect Polity consists in this; that if we admit a Divine Providence, to whose foresight we ascribe the final cause or ultimate tendency of the social union, it is a negative description of the policy which should be pursued in every well-

[1] *Eth. Nic.* x. c. *ult.*

[2] *Polit.* i. 2, iii. 6.

[3] Nobility, according to Aristotle, is "ancient wealth and virtue;" or "the virtue and wealth of ancestors;" and does not, in his view, therefore, form a distinct head of claims. According to Laertius, he wrote an express treatise, Περι Ευγενειας, in one book.

[4] Bishop Butler's picture of a perfectly virtuous kingdom will readily occur here. (*Analogy*, part i. chap. 3.)

[5] *Polit.* i. cap 2, φυσει μεν ουν ἡ ὁρμη, κ. τ. λ.

[6] *Polit.* iv. cap. 12, v. cap. 1.

constituted state. It points out the manner in which the public welfare must be sought; that is, by not making any one of the objects commonly pursued in the political world the sole or chief object of pursuit to the community. On the hypothesis, that the happiness of the world is the care of Him who ordered it, every society should be so constituted as that no appointment of Providence be overlooked, but every part of the social machinery be brought into action. The love of conquest, for instance, will not be the aim of such a state. Such a policy would employ its military resources only, to the exclusion of its other materials of happiness. Aristotle particularly points out this in the instance of Lacedemon, whose whole policy was framed for war; whereas, as he observes, a state should be adapted for living well in peace, and enjoying that repose which is the end of its engaging in war.[1] Nor, again, will the mere accumulation of wealth be the express aim of the state in its whole policy. Such a ruling principle would tend to degrade the great mass of the population, and to undo the very connection itself between the members of the community, by pushing the boundaries between the rich and poor to the extremes of opulence and pauperism; of which condition of things the natural result is, the tyranny of an Oligarchy. Lastly, if even liberty is made the exclusive aim of state policy, unhappiness is the sure result. Whilst the members of the community grasp at an unrestrained liberty, they disregard the various gradations of society, by which the sphere of human duties is enlarged, and the greatest securities against violations of liberty are provided; and thus a wild Democracy usurps the place of a just Polity. Now, Aristotle's theory excludes all such gross schemes of policy. It admits only the general pursuit of the public welfare; which, like the private happiness sketched in his Ethics, is not to be made a *distinct* object under any particular form, but must be the *general* pursuit of the *whole* organization of the society; as private happiness is the *result* of the *general* regulation of all the moral principles. It is true, that he supposes a society to constitute itself in order to its own moral perfection and happiness; and herein is the error of his theory. But this notion being a substitute in his system for a Divine Providence, it did not imply that the individual members of the community should propose to themselves, as their direct object of pursuit in life, that happiness to which the social system, as a whole, should tend. It was to be brought about by that mysterious agency which, from not admitting a real Providence, he was compelled to ascribe to Nature.

This is further illustrated in his description of the three right forms of government, and the three improper or deviations from the former. He admits that the public welfare may be promoted under other forms—under a Monarchy or an Aristocracy, as well as under "the Polity" or commonwealth. These three forms are indeed coincident in principle, according to him; being variations produced by differences in the character of the people among whom they arise.[2] The perfect "Polity" presupposes an equality among the members of the society,—that all are capable in turn of governing, as well as of being governed. But there may in some cases be marked differences between a family, or an individual, or a class of individuals, and the bulk of the people; and in these cases the rule of justice requires that there should exist in the former a monarchy, in the latter an aristocracy. So far, indeed, does Aristotle carry this principle as to say, that any single person eminent in worth above the rest of the community, as one of a more divine nature, ought to have entire obedience from the rest, and to be perpetual Sovereign.[3] The three forms, then, of Monarchy, Aristocracy, and Commonwealth, are right; because, being founded on the relative merit of the members of each society, and the standard of merit being virtue, the rule of justice is maintained in them. The public good follows, therefore, not from the ascendancy of this or that principle in the government in each case, but from a due regard to all subsisting relations in the state. But in the corresponding perversions of these right governments—in a Tyranny an Oligarchy, and a Democracy—particular principles prevail, and particular interests, accordingly, are consulted, to the violation of justice and the sacrifice of public good.

Aristotle appears the only political theorist among the ancients who never lost sight of the moral nature of man in his speculations. The systems of other theorists, as Plato, Phaleas of Chalcedon, Hippodamus of Miletus, and the constitutions of Lacedemon, Crete, and Carthage, for the most part treated Human Society merely as a physical mass, capable of being moulded into particular forms by the mechanism of external circumstances. Aristotle, on the contrary, lays the chief stress on the force of "customs, philosophy, and laws,"[4] for producing the best condition of society. Still as, in his Ethics, in order to the development of his theory of the Chief Good of man, he supposes a condition of human life adequate to the exercise of the moral powers; so, in his Politics, he supposes a concurrence of circumstances favourable to the existence of the perfect Polity.[5] In this theory as in that, there must be no impediment from without to the operation of the principles. Here, as in the Ethics, the production of the desired effect is the combination of three principles—Nature, Habit, Reason.[6] Therefore, also, as there must be certain elements of virtue in the heart in order to the moral improvement of an individual, so there must be the proper elements of the perfect social life in the community where the perfect commonwealth is to be reared. Then, upon these natural principles of the head and heart, a course of public Education is to proceed, disciplining the members by habit and by reason to the perfection of the social character, in a manner analogous to the discipline by the individual of his own character.

We find the same fundamental agreement with the moral system of the Ethics, in the method of Education proposed by Aristotle for the citizens of the perfect Polity. The maturity of the intellectual powers is here also to be the end to which the system tends. The members of the community are to be trained so as to be capable of enjoying the leisure and repose of a peaceful state. This they are to regard as their ultimate proper sphere of happiness; whilst at the same time they are disciplined to the virtues of that active life, by which alone the permanence of their tranquillity can be secured. It is obvious how this harmonizes with the doctrine of the Ethics, which sets forth the happiness of the Theoretic life as the highest bliss of man's nature, but not independently of the practical duties of common life. For thus he directs the course of training through which the young must pass, to commence with the body; then to proceed to the disposition of the heart, and to end with the intellect; the inferior principles being disciplined in subordination to, and with reference to the higher. Even the sports of childhood were not neglected by him in the scale of Education. He would further provide for the best bodily constitution of the citizen, by regulating the period of marriages with a view to a healthy offspring, and the care of the mothers during pregnancy. Here, indeed, we are shocked at finding in such an author a sanction to infanticide and abortion. The law, he says, should forbid the nurturing of the maimed;[7] and where a

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1 *Polit.* ii. cap. 9, vii. cap. 14.
2 *Ibid.* iii. cap. 17.
3 *Ibid.* iii. cap. 13, p. 355. Du Val.
4 *Polit.* ii. cap. 3.
5 *Ibid.* vii. cap. 1, 12.
6 *Ibid.* vii. cap. 13.
7 *Polit.* vii. cap. 16, εστω νομος μηδεν πεπηρωμενον τρεφειν.

check to population is required, abortion should be produced before the quickening of the infant; no law of morality he thinks, forbidding it at this period.[1] These are striking instances of the infirmity of a philosophy, which substitutes an intrinsic agency in Nature for the counsels of an intelligent Divine Agent working on Nature. According to such a philosophy, everything adverse to the perfection of Nature is a stumbling-block. On the hypothesis of a Providence, the good and the evil may be contemplated with equal assurance that "the best" will in the end prevail. In the former case human reason removes, suppresses, destroys; in the latter it moderates, counteracts, overrules; doing nothing with rash violence, but gently conspiring with the appointed course of things, in opening a way for good out of the evil. In Aristotle, the immoralities here noticed are, moreover, at direct variance with the precepts and spirit of his Moral philosophy.

Again, the same moral complexion characterizes both the public and private discipline of the philosopher. The honourable, *το καλον*, predominates over both. By this standard every institution, whether of bodily or mental exercise, is to be regulated. No illiberal arts, such as required manual rather than intellectual skill, are to be taught. Not even are the liberal sciences to be pursued excessively, or with exclusive devotion to any particular ones, or with mercenary views; the occupation of leisure being the end proposed by the system of education. What was useful or necessary was to be learned, but in subserviency to the honourable; and the honourable rather than the useful or necessary.[2] Hence the stress laid by Aristotle on the arts of Painting and Music. It was, in the result, a general cultivation of the mind by literature combined with moral discipline, and not the storing it with particular sciences, which his system of Education contemplated. He saw that the tendency of particular studies was to contract the mental powers to that particular range of vision to which they were confined: whereas he sought rather to impart a largeness and masculine strength to the understanding, commensurate with the varied demands of the world in which human life is cast. It was what we should express by the education of the accomplished gentleman,—of one who, exempt from the drudgery of life, and having his actions freely at his own disposal, might be qualified for the highest functions to which nature has destined man in forming him a moral and social being. For it should be observed, that Aristotle throughout supposes an entire immunity from all servile employments, both to the happy man and the happy citizen.[3] According to his view, a large proportion of mankind are physically incapable, either of the happiness of moral beings, or of that of social life. Persons so imperfectly constituted he conceives to be wholly dependent on others, and to be by nature *relative* beings or slaves; their proper nature being comprised in this relationship of dependence.[4] To this class, accordingly, he would commit all the labours of agriculture, of the mechanical arts, and the market, and all menial offices: whilst others, more gifted by nature, enjoy leisure for the proper duties of man, in the various relations of a moral and social being.[5]

The justification of the condition of slavery is thus rested by Aristotle on abstract grounds. He viewed it as an institution of nature; differing in this from other philosophers, and from the popular notion of his own countrymen, who either founded it on the right of conquest, or on an assumed original difference between Greek and Barbarian. This was a far more liberal view of the subject than that which prevailed generally in his time. For it implied, that no one had a right to retain another as his slave who was not thus physically dependent. Every one had a right to be free, who was capable of enjoying freedom in the performance of the duties for which man in his perfection was constituted. This doctrine further imposed on the master a strict moral attention to his slave. The slave was thrown on him not only for support, but for direction in his duties.[6]

That Religion should have formed no part of the business of Education in his system, was further consistent with his Ethics. The Moral *καλον* terminated in the perfect fulfilment of all those relations in which man was placed as a being of this world. It was heightened by the consideration, that Gods might delight in looking down on such perfection, and that in its highest state it resembled the excellence of divinity. But it did not strike its roots into, or draw its nourishment from, Religion. Nor did the *καλον* of Social life. The accomplished citizen might be taught to contemplate himself in the thoughtful activity of a philosophical leisure, as holding a dignified station among men, analogous to the divine principles which maintain the order of the universe.[7] But there was no connection between his social virtues and his religious system. The religious colouring was only the borrowed light of Philosophy. All active Religion was consigned to the instrumentality of a particular body of men—the Priests. The obligatory force of Religion was recognised; but being lodged in an external establishment, as its depository and sanctuary, reverence was sought for it by outward bonds of respect, by the privileges of the order to whose care it was intrusted, and the splendour of its public spectacles. Aristotle, accordingly, treats the subject merely as one of policy. He observes, that no one of the rank of a mechanic or peasant should be appointed a Priest, since it was necessary that the gods should be honoured by the citizens; and he points out the importance of the religious character to the absolute sovereign of a state, in order to the obedience of the subject.[8]

Aristotle's account of his theoretic Polity leaves off abruptly at the end of the 8th book; and the treatise is thus, as now extant, an imperfect development of his views. But the theory of the Perfect Polity is only a part of the very valuable materials of the *Politics*. The work embraces a wide survey of the social nature of man. Throughout, indeed, it may be studied as elements of the philosophy of History. It lays open the principles of preservation and decay inherent in the different constitutions, and points out the common principles on which the maintenance of civil order, under any form whatever, must essentially depend.

Nor has the study which now obtains the name of Political Economy been overlooked by Aristotle. The nature of Money, and of the wealth to which it has given rise, particularly attracted his attention. It may suffice to shew how accurately he thought on the subject, to observe that his account of the origin of Money,—tracing it to its service, as a common measure of value in exchanges, and as a conventional substitute for a demand for commodities,—has been adopted by the author of the celebrated work, *The Wealth of Nations*.[9]

On the whole, justly to appreciate the labours of Aristotle in Political Science, we should compare them with the elaborate and eloquent works of Plato on the same subject—the

[1] *Polit.* vii. 16, πριν αισθησιν εγγινεσθαι και ζωην, εμποιεισθαι δει την αμβλωσιν, κ. τ. λ.

[2] *Ibid.* vii. cap. 14.

[3] *Eth. Nic.* x. cap. 6, 7; *Polit.* iii. cap. 6, iv. 4.

[4] *Polit.* i. cap. 3, 6.

[5] *Ibid.* vii. cap. 9, 10.

[6] *Ibid.* i. cap. 13. νουθετητεον γαρ μαλλον τους δουλους η τους παιδας.

[7] *Polit.* vii. cap. 3, Σχολη γαρ αν ὁ θεος εχοι καλως. και πας ὁ κοσμος, ὁις ουκ εισιν εξωτερικαι πραξεις παρα τας οικειας τας αυτων. "Sic hominum ad duas res, ut ait Aristoteles, ad intelligendum et agendum, esse natum, quasi mortalem Deum." (Cicero *De Fin.* ii. cap. 13.)

[8] *Polit.* v. 11, vii. 9. In *Œconom.* i. 5 (probably the work of his disciple Theophrastus), slaves are spoken of as the class for whom especially sacrifices and festivities should be appointed.

[9] *Ibid.* i. 9; *Eth. Nic.* v. 5. Adam Smith's *Wealth of Nations*, book i. chap. 5.

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Dialogues entitled *The Republic* and *The Laws*, and especially *The Republic*. Aristotle evidently had this work before him in the composition of his own, and in several places has made express allusions to it. His two treatises of the *Nicomachean Ethics* and the *Politics*, convey incidentally a refutation of the errors in moral and political philosophy contained in Plato's speculations. It is but a small portion of Plato's *Republic* which belongs to Politics; the bulk of it being devoted to moral and metaphysical discussions. Aristotle's more exact philosophy discriminates the subjects strangely though beautifully blended in that episodic work. He has taken much of what is excellent in the treatises of Plato into his own; but at the same time has the merit of originality, in the correction and enlargment, as well as systematic arrangement, of the principles there diffusely delivered. He acknowledges, referring to the *Dialogues* of Plato, that all the discourses of Socrates have in them "the admirable, and the exquisite, and the inventive, and the searching;" whilst he claims a right to discuss them, on the ground, that "for everything in them to be right was perhaps difficult."[1]

Plato's theory was metaphysical throughout. That oneness which he sought to establish in his perfect Republic was an abstract unity, the realizing of which constituted, in his view, the best Polity; as the realizing of the one self-existent "idea" of good constituted the morality of actions. Thus, his Magistrates are philosophers, and his Virtue is wisdom. A character, on the other hand, decidedly practical, pervades the moral and political disquisitions of Aristotle. They are immediately adapted to the actual needs of man. They have not, on this very account, that peculiar charm which belongs to Plato's writings. The imaginative perfection shadowed out by Plato, imparts an interest even to his subtile disputations, and engages the feelings of the reader, amidst the reluctance of his judgment. And thus his works tend to a practical effect, in opposition to their speculative character. But Aristotle, throughout intent on the business of human life, forbears to seize the imagination with romantic pictures of excellence, either in man individually, or in society. He points out such happiness as is attainable, or at least to which human endeavours may reasonably be directed, in that condition of the world in which man has been placed. His discussions on moral subjects are accurate observations, and powerful reasonings, applied to things as they are. But this character renders them of more general use than Plato's speculations. The man of genius and of sensibility might feel a stronger stimulant to moral and social energies from the study of the animated pages of the *Republic*. But the generality of mankind would undoubtedly obtain a more ready help in the duties of life, from the practical principles of conduct delivered in the less ambitious philosophy of Aristotle.

CONCLUSION.

Design of Aristotle's Philosophy—Style of his Writings—His Obscurity—Method of Discussion—Originality.

From the review which has been taken of the extant writings of Aristotle, it would appear that the great object of the philosopher was to discipline the mind by a deep and extensive course of literature. The various inquiries embraced in those writings,—the unwearied research into subjects the most repulsive from their abstruseness, or the most interesting from their connection with the feelings and actions of men,—the richness of illustration from the volumes of ancient genius, and from observations of mankind with which they abound, are so many proofs of the noble object proposed in his philosophy. It may be fully concluded that it was not the mere sophist of former days, or the disputant on any given question, that Aristotle aimed to accomplish. His object was, like that of Socrates, to render man really wise, by a cultivation of all the moral and intellectual powers of the soul; in order that the great moral of the whole—the good towards which Nature tends—might be realized in each individual so instructed and disciplined. Agreeably to this view is the answer attributed to him, when, on being asked what advantage had accrued to him from philosophy, he replied "To do without constraint what some do through the fear of the laws."[2]

Some of his works appear to have been written in the form of Dialogue. These were probably of the class called Exoteric; that form being more adapted to the purpose of explanation and fuller discussion,—which seem to have been characteristics of the Exoteric treatises,—in contrast with the concise and suggestive form of the Esoteric or Acroamatic. Among his works are also mentioned *Epistles* to Philip, to Alexander, Olympias, Hephæstion, Antipater, Mentor, Ariston, Themistagoras, Philoxenus; besides a collection entitled *Epistles of the Selymbrians*. A hymn in praise of the virtues of his friend Hermias has been already noticed; which formed matter of accusation against him on the ground of impiety. It has been preserved by Diogenes Laertius. It consists of twenty-three lyric verses, celebrating Hermias among the heroes who had sacrificed their lives for the cause of virtue. Laertius has also preserved four lines inscribed by him on the statue of Hermias erected at Delphi. His poetical talent was further displayed in verses addressed to Democritus, and in the composition of an elegy; of both which poems the first lines are given by Laertius. The titles of various other works, or parts of works, occur in the catalogue of his writings. So laborious, and so diversified, were the literary pursuits of this great philosopher. These were works, too, written, we must remember, not by a sequestered individual, enjoying the privacy of a privileged leisure like the Priests of Egypt, but amidst the agitation and troubles of Grecian politics, or in the courts of princes. We may well, therefore, wonder at the abstractedness of mind, the single-hearted zeal of philosophy, which thus steadily pursued its course, creating its own leisure, and keeping the stillness of its own thoughts. Probably, indeed, such writings could hardly have been produced, except with a concurrence of such opposite circumstances. They imply at once the man of the world and the retired student,—ample opportunities for the contemplation of human nature in the various relations of life, familiarity with the thoughts of others by reading and conversation, as well as intense private meditation, that communing with a man's own heart, which alone can extort the deep secrets of moral and metaphysical truth.

The style of his writings bears the impress of his devotion to the real business of philosophy. The excellence of his style is, we believe, the last thing to attract the notice of his readers; and yet, as a specimen of pure Greek, it is found to stand almost unrivalled. The words are selected from the common idiom; but they are employed with the utmost propriety; and by their collocation are made further subservient to the perspicuity and force of his meaning. There is nothing superfluous, nothing intrusive, in his expressions; but the very ornaments add to the terseness of the style. The metaphors and illustrations employed are apt and striking analogies, availing as arguments, whilst by their simplicity they familiarize the truth to the mind. That these excellencies should escape the notice of the reader engaged

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[1] *Polit.* ii. 6. Το μεν ουν περιττον εχουσι παντες οἱ του Σωκρατους λογοι, και το κομψον, και το καινοτομον, και το ζητητικον· καλως δε παντα ἰσως χαλεπον.

[2] Diog. Laert. *in Aristot.*

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in the matter itself of the author, is a proof of the strict adaptation of the style to the matter. We can imagine, that to the Greek reader nothing could have been easier than to apprehend the meaning of the philosopher. To the modern, the necessity of studying the language gives an apparent hardness to expressions, whose propriety depends on an accurate perception of the genius of the language. Thus, what was a facility to the ancient reader is a difficulty to the modern, until the latter, by study of the language, has brought himself as much as possible into the situation of the former. This observation will be illustrated by a comparison of the style of Plato with that of Aristotle. Plato's style, undulating with copiousness of diction, is more attractive to the modern reader; his meaning is often more readily apprehended at the first glance, by the number of expressions which he crowds on a point, and their accumulated force of explanation. But in Aristotle, if we miss the force of a term or a particle,[1] or overlook the collocation of the words, we shall sometimes entirely pervert his meaning.

There are, however, passages in which Aristotle departs from his usual conciseness, and approaches towards the eloquence of Plato. The concluding chapters of his *Nicomachean Ethics* may here be particularly pointed out; or a part of the ninth book of that treatise, in which, evidently imitating Plato, he compares the tumult of uncontrolled passions to the disturbance of civil sedition. There is a dignity and a pathos in these passages, controlled by the general character of severe precision belonging to his style, yet admirably harmonizing with it. Sometimes, indeed, his style is chargeable with too strict a conciseness, as well as, on the other hand, with prolixity. These opposite faults are in him the same in principle; resulting from the pursuit of extreme accuracy;—an error in composition, compared by himself to that illiberality, which consists in too close an attention to minute matters in contracts.[2]

Nor can it be denied that there is considerable obscurity in the writings of Aristotle. It is important, however, to distinguish this obscurity from that of mere style. It is an effect of the peculiar design with which he appears to have composed them. Some are evidently outlines for the direction of the philosopher himself and his disciples in their disputations—notices of points of inquiry rather than full discussions of the subjects. This is very observable in the *Metaphysics*, the *Nicomachean Ethics*, and the *Rhetoric*. Sometimes he contents himself with a reference to his exoteric discussions.[3] It is probable that the most important works of his philosophy were not published in his lifetime; and that they thus constantly remained by him to receive improvements which further observation might suggest. This may partly account for some abruptness in those treatises. In our progress through them, we come to discussions which we had not been led to expect by anything previous in the work. The seventh book of the *Ethics*, for instance, appears to have been an afterthought; and so also the eighth and ninth of the same treatise. The work might have been regarded as complete in itself without them. In the *Metaphysics*, indeed, we can hardly judge what was the exact arrangement of the work; since it has descended to us in an imperfect, irregular form. But there are like marks in it of successive additions from the author.[4] The fact that the writings of Aristotle were left to Theophrastus, and not to his own relatives, would further imply, that they were intended primarily for those who had been trained in his school, and by whom his philosophy would be rightly transmitted. The immediate occasion of this reserved mode of writing may have been the jealousy of rival philosophers,[5] or the dread of pagan intolerance.

His method of discussion is conformable with the principles proposed in his Dialectical treatises. It is throughout a sifting of the opinions and questions belonging to the subject of inquiry, by examining each in its several points of view, and shewing the consequences involved in it. Accordingly, generally, before fully stating his own conclusions, he considers what may be urged on both sides of the question, putting the objections strongly and fairly, and giving the most candid construction to the views of his predecessors.[6] The difficulties proposed he sometimes briefly removes in passing on, having just glanced at them; at other times he devotes several sentences to their explanation. This, which is his method in parts of his system, is only a specimen of what is the collective result of the whole. His philosophy, dialectically viewed, is an analysis of the theories proposed by the philosophers who had preceded him. Consistently with this, he commences sometimes with observations on logical grounds,[7] or those views of a thing implied in the classifications which language expresses; and afterwards inquires into the subject physically or philosophically; when the discussion proceeds on principles of physics or philosophy in general.

With respect to the originality of his writings, there can be no doubt that he derived important aid from the labours of his predecessors, and especially from those of Plato. An accurate examination of his writings will convince the reader, that they are the productions of one who had deeply drunk of the fountain of Plato's inspiration. But they shew at the same time such a disciple as we may suppose the spirit of Plato would have delighted in; one who cherished the authority of the preceptor, and yet had the courage to love the truth still more;[8] one who thought it necessary to consult what others had said wisely and truly before him, and yet would examine a question finally with an independent discriminative judgment.[9] Estimating his philosophy thus, we may pronounce it to be truly his own. It was the fruit of his own sagacious, penetrating mind. A sufficient proof of this is his disagreement with Plato on the theory of Ideas,—the Origin of the universe,—and the Immortality of the soul. He has been charged, indeed, with invidious opposition to Plato, with corruption and misrepresentation of the tenets of his predecessors. Jewish writers have even absurdly accused him of plagiarism from the books of Solomon.[10] But there is no real foundation for these charges; they are at best but surmises; and they are fully contradicted by the internal evidence of the writings themselves. (R. D. H.)

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[1] It is probable that the number of his distinct works has been made to appear larger than it really is, by the circumstance of parts of those now extant being described by the titles of the particular subjects to which they refer, and thus represented as separate treatises.

[2] *Metaph.* ii. 3. [3] *Eth. Nic.* i. c. ult., λεγεται δε περι αυτης και εν τοις εξωτερικοις λογοις αρκουντως ενια, και χρηστεον αυτοις. *Ibid.* vi. 4, πιστευομεν δε και περι αυτων και τοις εξωτερικοις λογοις. *De Cœlo*, i. 9, καθαπερ εν τοις εγκυκλιοις φιλοσοφημασι. *Eudem.* i. 8.

[4] Niebuhr (*History of Rome*, trans. p. 16) remarks this particularly of the *Rhetoric*.

[5] Valerius Maximus, viii. 14, reprehends Aristotle's sensitiveness on this point, mentioning his annoyance at the authorship of his *Rhetoric* being imputed to Theodectes, to whom he had presented the work for publication, and his care to assert his right to the treatise in a subsequent work. [6] *Metaph.* iii. 1; *Topic.* i. 2; *Cœlo*, ii. 13, &c.

[7] *Ibid.* vii. 4; *Polit.* vii. 5. Occasionally he illustrates from etymology, as in deducing ηθος from εθος (*Eth. Nic.* ii. 1), σωφροσυνη from σωζειν φρονησιν (*Eth. Nic.* vi. 5). "It is a practice with us all," he observes (*Cœlo*, ii. 13, p. 467), "to pursue an inquiry, not as it belongs to the thing, but relatively to an opponent in argument."

[8] *Eth. Nic.* i. 6, αμφοιν γαρ οντοιν φιλοιν, ὁσιον προτιμαν την αληθειαν. This is also the sentiment of Plato, *Rep.* x. αλλ' ου προ γε της αληθειας τιμητεος ανηρ. [9] *De Cœlo*, i. 10, το γαρ ειρηνην καταδικαζεσθαι δοκειν, κ. τ. λ.; *Polit.* ii. 6; *Metaph.* xiv. 8, p. 1002, Du Val.

[10] Brucker, *Hist. Crit. Phil.* vol. i. p. 794. This was merely to excuse their own adoption of his philosophy, as Brucker observes.

ARISTOXENUS, a Peripatetic philosopher, and native of Tarentum. He studied under Lamprus, Xenophilus, and Aristotle; and, according to Suidas, was the author of 453 works on music, philosophy, and history. The only one of these that is now known is his *Elements of Harmonics*, in three books, of which Meibomius published an edition with Latin translation and notes in his *Antiquæ Musicæ Auctores*, Amsterdam, 1652. This is considered the best edition of Aristoxenus's work, although it is imperfect; for part of each book is wanting, and great confusion occurs from transposition of passages. The Abate J. Morelli, librarian of St Mark's library at Venice, published fragments of Aristoxenus's *Elements of Rhythm* from a MS. in that library, Venice, 1785. By the term ἁρμονία, the ancient Greeks did not mean *harmony* in the modern sense of that word as applied to music, but the system of sounds upon which *melody* for voice or instrument was founded. It is remarkable that Aristoxenus, after asserting that the ear is the sole judge of harmonic [melodic] intervals, should have plunged into a system of false calculations of these intervals. He, like the other Greek writers on music, has given us no information regarding the practical parts of the art, either in composition or performance.

Aristoxenus || Arithmetic

ARITHMETIC

Is a science which explains the properties of numbers, and shows the method or art of computing by them.

I.—HISTORY OF ARITHMETIC.

In the early periods of society a vast mound of earth, or a huge block of stone, was the only memorial of any great event; but after the simpler arts came to be known, efforts were made to transmit to posterity the representations of the objects themselves. Sculptures of the humblest kind occur on monumental stones in all parts of the world, sufficient to convey tolerably distinct images of the usual occupation and employments of the personages so commemorated. The next step in the progress of society was to reduce and abridge those rude sculptures, and thence form combinations of figures approaching to the hieroglyphical characters. At this epoch of improvement the first attempts to represent numerals would be made. Instead of repeating the same objects, it was an obvious contrivance to annex to the mere individual the simpler marks of such repetition. Those marks would of necessity be suited to the nature of the materials on which they were inscribed, and the quality of the instruments employed to trace them. In the historical representations, for instance, which the Mexicans and certain Tartar hordes painted on skins, a small coloured circle, as exhibiting the original counter, shell, or pebble, was repeated to denote numbers. But on the Egyptian obelisks the lower numbers, at least, are expressed by combined strokes. Curve lines were not admitted in the earliest rudiments of writing. Even after the use of hieroglyphics had been laid aside, and the artificial system of alphabetic characters adopted, the rectilineal forms were still preferred, as evidently appears in the Greek and Roman capitals, which, being originally of the lapidary sort, are much older than the small or current letters. One of the most ancient sets of characters, the Runic, in which the northern languages were engraved, combines almost exclusively simple strokes at different angles.

The primary numeral traces may, therefore, be regarded as the commencement of a philosophical and universal character, drawn from nature itself, and alike intelligible to all ages and nations. They are still preserved, with very little change, in the Roman notation. Those forms, prior to the adoption of the alphabet itself, were no doubt imported by the Grecian colonies that settled in Italy, and gave rise to the Latin name and commonwealth. Assuming a perpendicular stroke | to signify *one*, another such || would express *two*, the junction of a third ||| *three*, and so repeatedly till the reckoner had reached *ten*. (See Plate LXXII.) The first class was now completed, and to intimate this the carver threw a dash across the stroke or common unit; that is, he employed two decussating strokes X to denote *ten*. He next repeated this mark to express *twenty*, *thirty*, and so forth, till he finished the second class of numbers. Arrived at *an hundred*, he would signify it by joining another dash to the mark for ten, or by merely connecting three strokes thus ⊏. Again, the same spirit of invention might lead him to repeat this character in denoting *two hundred*, *three hundred*, and so forth, till the *third* class was completed. *A thousand*, which begins the fourth class on the *Denary Scale*, was therefore expressed by four combined strokes M, and this was the utmost length to which the Romans first proceeded by direct notation.

But the division of these marks afterwards furnished characters for the intermediate numbers, and hence greatly shortened the repetition of the lower ones. Thus, having parted in the middle the two decussating strokes X denoting *ten*, either the under half Λ, or the upper half V, was employed to signify *five*. Next, the mark ⊏ for an hundred, consisting of a triple stroke, was largely divided into Γ and L, either of which represented *fifty*. Again, the four combined strokes M, which originally formed the character for *a thousand*, came afterwards, in the progress of the arts, to assume a rounded shape ᗰ, frequently expressed thus CIƆ, by two disparted semicircles divided by a diameter. This last form, by abbreviation on either side, gave two portions cI and Iɔ to represent *five hundred*.

Origin of Roman numerals.

It was an easy process, therefore, to devise a universal character for expressing numbers. But the task was very different to reduce the exhibition of language in general to such concise philosophical principles. This attempt seems accordingly to have been early abandoned by all nations except the Chinese. The inestimable advantage of uniting again the whole human race, in spite of the diversity of tongues, by the same permanent system of communication, was sacrificed for the easier attainment of representing by artificial signs those elementary and fugitive sounds into which the words of each particular dialect could be resolved. Hence the Alphabet was invented, which had very nearly attained its present form at the period when the Roman commonwealth was extending its usurpation over Italy. About that epoch a sort of reaction seems to have arisen between the artificial and the natural systems; and the numeral strokes were finally displaced by such alphabetic characters as then most resembled them. (See Plate LXXII.) The ancient Romans employed the letter I to represent the single stroke or mark for *one*; they selected the letter V, since it resembles the upper half of the two decussating strokes or symbol, for *five*; the letter X exactly depicted the double mark for *ten*; again, the letter L was adopted as resem-

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bling the divided symbol for *fifty;* while the entire symbol, or the tripled stroke, denoting *an hundred,* was exhibited by the hollow square ⊏, the original form of the letter C before it became rounded over. The quadrupled stroke for a *thousand* was distinctly represented by the letter M, and its variety by the compound character cIↄ, consisting of the letter I inclosed on both sides by C, and by the same letter reversed; a portion of this, again, or Iↄ, being condensed into the letter D, expressed *five hundred.* The letters C and M, beginning the words *Centum* and *Mille,* might have a farther claim to represent an *hundred* and *a thousand;* but the coincidence was merely accidental, since these terms migrated probably from the Greek words ἑκατον and χιλια.

This was the limit of numeration among the early Romans; but, in the progress of refinement, they repeated the symbols of a thousand to denote the higher terms of the Denary Scale. Thus, ccIↄↄ was employed to represent *ten thousand,* and cccIↄↄↄ to signify *an hundred thousand,* the letter I, inclosed between the c ↄ, being, for the sake of greater distinctness, elongated. Again, each of these being divided, gives Iↄↄ for *five thousand,* and Iↄↄↄ for *fifty thousand.* These characters, however, were often modified and abbreviated in monumental inscriptions. By drawing a horizontal line over the letters, their value was augmented *one thousand times.* In the plate so often referred to, we have endeavoured, from the best authorities, to exhibit, under the title of *Lapidary Numerals,* a complete specimen of the various contractions used by stone-cutters among the Romans. It was customary with them, for the sake of abbreviation, to reckon, as rude tribes are apt to do, partly backwards. Thus, instead of *octodecem* and *novemdecem,* the words for *eighteen* and *nineteen,* they frequently used *duodeviginti* and *undeviginti,* as more elegant and expressive. This practice led to the application of *deficient* numbers, an improvement scarcely to be expected from a people so little noted for invention. Instead of writing *nine* thus, VIIII, by joining *four* to *five,* they counted *one* back from *ten,* or placed I before X. In the same way they represented *forty,* and *four hundred, ninety,* and *nine hundred,* by XL, and CD, XC, and CM.

Such, we have no doubt, is the real account of the rise and progress of the Roman numerals. It perfectly agrees with the few hints left us by Aulus Gellius, who expressly says that I and X were anciently represented by one and two strokes; though philologers, misled by partial glimpses, have indeed given a very different statement. Priscian the grammarian, who flourished in the reign of the emperor Justinian, asserts that the mark I was only borrowed from the Athenians, being adopted by them as the principal letter of the word ΜΙΑ, or *one,* the M of which is considered as mute; that V or U was employed by the Romans to denote *five,* because it is the fifth vowel in the common order; that X was assumed to represent *ten,* as being the tenth consonant, and likewise following the V; that L was taken to signify *fifty,* being sometimes interchanged with N, which, as a small letter, expressed that number among the Greeks; that C was adopted to mark *an hundred,* because it is the first letter of the word *centum;* that D, being the next letter of the alphabet, was employed to signify *five hundred;* and that M was borrowed from the Greek letter Χ for ΧΙΛΙΑ, or *a thousand,* only that it was rounded at the ends to distinguish it from the symbol for ten.

After the system of Roman numerals, however, had acquired its full extent, the solicitude of superstition long preserved some traces of the rudest and most primitive mode of chronicling events. At the close of each revolving year, generally on the ides of September, the Prætor Maximus was accustomed, with great ceremony, to drive a *nail* in the door on the right side of the temple of Jupiter, next that of Minerva, the patron of learning and the inventor of numbers. On such occasions they elected a dictator for the sole purpose of driving the sacred nail, and beginning a more propitious year. Hence the expression of Cicero—*Ex hoc die, clavum anni movebis.*

Chinese numerals.

As the Chinese constructed the Swan-pan on the principles of the Roman Abacus (See Abacus), so they likewise, at the remotest epoch of the empire, framed a system of numerals in many respects similar to those which the Romans probably derived from their Pelasgic ancestors. This will appear from the inspection of the characters engraved on Plate LXXII. It is only to be observed that the Chinese mode of writing is the reverse of ours; and that, beginning at the top of the leaf, they descend in parallel columns to the bottom, proceeding, however, from right to left, as practised by most of the Oriental nations.

Instead of the vertical lines used by the Romans, we therefore meet with horizontal ones in the Chinese notation. Thus, *one* is represented by a horizontal stroke, with a sort of barbed termination; *two* by a pair of such strokes; and *three* by as many parallel strokes; the mark for *four* has four strokes, with a sort of flourish; three horizontal strokes, with two vertical ones, form the mark for *five;* and the other symbols exhibit the successive strokes abbreviated, as far as *nine.* *Ten* is figured by a horizontal stroke, crossed with a vertical score, to show that the first rank of the Denary Scale was completed; *an hundred* is signified by two vertical scores, connected by three short horizontal lines; *a thousand* is represented by a sort of double cross; and the other ranks, ascending to *an hundred millions,* have the same marks successively compounded. In addition to the figures in the Plate, we shall here give *fac similes* of a complete set of numerals, printed with metallic types in 1814, at Serampore, in the Elements of Chinese Grammar, by the Reverend Dr Marshman. In these characters, it will be perceived that each symbol has, for the sake of distinction, a small zero or ° annexed to it.

One,	一	*Yih.*	*Ten,*	十	*Shih.*
Two,	二	*Irr.*	*A Hundred,*	百	*Pŭh.*
Three,	三	*San.*	*A Thousand,*	千	*Ts'hyen.*
Four,	四	*Sè.*	*Ten Thousand,*	萬	*Wàn.*
Five,	五	*Ngóo.*	*A hundred Thousand,*	億	*Eè.*
Six,	六	*Lyeù.*	*A Million,*	兆	*Chaò.*
Seven,	七	*Ts'hìh*	*Ten Millions,*	京	*King.*
Eight,	八	*Păh.*	*A hundred Millions,*	垓	*Kyai.*
Nine,	九	*Kyéu.*			

The numbers *eleven, twelve,* &c. are represented by putting the several marks for *one, two,* &c. the excesses above *ten,* immediately below its symbol. But to denote *twenty, thirty,* &c. the marks of the multiples *two, three,* &c. are placed above the symbol for *ten.* This distinction is pursued through all the other cases. Thus, the marks for *two, three,* &c placed over the symbols of *an hundred* or of

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a thousand, signify so many *hundreds* or *thousands*. The character for *ten thousand*, called *wàn*, appears to have been the highest known at an early period of the Chinese history; since, in the popular language at present, it is equivalent to *all*. But the Greeks themselves had not advanced farther. In China, *wàn wàn* signifies *ten thousand times ten thousand*, or *an hundred millions;* though there is also a distinct character for this high number. In the eastern strain of hyperbole, the phrase *wàn wàn* far outdoing *a thousand years*, the measure of Spanish loyalty, is the usual shout of long live the emperor! The Chinese character *chaò* for *a million*, though not of the greatest antiquity, is yet as old as the time of Confucius. The characters for *ten* and for *an hundred millions* are not found in their oldest books, but occur in the imperial dictionary.

Such is the very complete but intricate system of Chinese numerals. It has been constantly used, from the remotest times, in all the historical, moral, and philosophical compositions of that singular people. The ordinary symbols for words, or rather things, are, in their writings, generally blended with skill among those characters. But the Chinese merchants and traders have transformed this system of notation into another, which is more concise, and better adapted for the details of business. The changes made on the elementary characters, it will be seen, are not very material. The *one, two,* and *three,* are represented by perpendicular strokes; the symbols for *four* and *five* are altered; *six* is denoted by a short score above an horizontal stroke, as if to signify that *five*, the half of the index of the scale, had been counted over; *seven* and *eight* are expressed by the addition of one and two horizontal lines; and the mark for *nine* is composed of that for *six*, or perhaps at first a variety of *five*, joined to that of *four*.

〡	*One.*
〢	*Two.*
〣	*Three.*
〤	*Four.*
〥	*Five.*
〦	*Six.*
〧	*Seven.*
〨	*Eight.*
〩	*Nine.*

To represent *eleven, twelve,* &c. in this mode, a single stroke is placed on the left of the cross for ten, and the several additions of *one, two,* &c. annexed on the right.

From *twenty* to *an hundred*, the signs of the multiples are prefixed to the mark for *ten*.

〢十	*Twenty.*	〢一 十	*Twenty-one.*
〣十	*Thirty.*	〣一 十	*Thirty-one.*
〤十	*Forty.*	〤一 十	*Forty-one.*
〥十	*Fifty.*	〥一 十	*Fifty-one.*
〧十	*Seventy.*	〧〣 十	*Seventy-three.*

The same method is pursued through the hundreds, the marks of the several multiples being always placed on the left hand before the contracted symbol of *pŭh*, or *an hundred*. The additions are made on the right, with a small cipher or circle (o), called *ling*, when necessary, to separate the place of units. The distinction between *two hundred and three* and *five hundred and thirty* deserves to be particularly remarked.

〢 百	*Two hundred*	〢〇〣 百	*Two hundred and three.*
〥 百	*Five hundred.*	〥〣 百	*Five hundred and thirty.*
〧 百	*Seven hundred.*	〧〨〢 百	*Seven hundred and eighty-two.*

A similar process extends to the notation of thousands, but for ten thousand the character *wàn* is abbreviated. As a specimen of their combination, we select the following complex expression,

〥〤〣〤〧〥〇〇〣
万千百十万

which denotes *five hundred and forty-three millions, four hundred and seventy-five thousand, and three.* The same number would be thus represented in the regular system of Chinese notation:—

零萬四千五
三五十三萬
千七百四

Here the first column on the right hand presents the marks for *fifty* and *four*, with the interjacent character *wàn*, or *ten thousand;* the next column to the left has the several marks for *a thousand, three,* and *an hundred;* the middle column exhibits the symbols of *forty* and of *seven;* the adjacent column repeats the character *wàn*, or *ten thousand*, and then presents those for *five* and *a thousand;* and the last column has the symbol *ling*, or the *rest*, which fills up the blank, with the mark for *three.*

The last expression seems abundantly complicated, and yet it is unquestionably simpler and clearer than the corresponding notation with Roman numerals, as represented below.

IↃↃↃↃↃↃↃ · CCCCCIↃↃↃↃↃ ·
CCCCCIↃↃↃↃↃ · CCCCCIↃↃↃↃↃ ·
CCCCCIↃↃↃↃↃ · CCCCIↃↃↃↃ ·
CCCCIↃↃↃↃ · CCCCIↃↃↃↃ · CCCIↃↃↃ ·
CCCIↃↃↃ · CCCIↃↃↃ · CCCIↃↃↃ
IↃↃↃ · CCIↃↃ · CCIↃↃ · IↃↃ · III.

From such an intricate example, the imperfection of the Roman system will appear the more striking.

The abbreviated process of the Chinese traders was probably suggested by the communication with India, where the admirable system of denary notation has, from the earliest ages, been understood and practised. The adoption of a small cipher to fill the void spaces was a most material improvement on the very complex character *ling*, used formerly for the same purpose.

About the close of the 17th century, the Jesuit missionaries Bouvet, Gerbillon, and others, then residing at the court of Pekin, and able mathematicians, appear to

have still farther improved the numeral symbols of the Chinese traders, and reduced the whole system to a degree of simplicity and elegance of form scarcely inferior to that of our modern ciphers. With these abbreviated characters they printed, at the imperial press, Vlacq's *Tables of Logarithms*, extending to ten places of decimals, in a beautiful volume, of which a copy was presented by Father Gaubil, on his return to Europe, about the year 1750, to the Royal Society of London. From this very curious work, the marks in Plate LXXII. entitled Improved Chinese Numerals, were carefully copied. No more than nine characters, it will be seen, are wanted; the upright cross + for *ten* being a mere redundancy. The marks for *one*, *two*, and *three*, consist of parallel strokes as before; an oblique cross × denotes *four;* and a sort of bisected ten signifies *five*. This symbol again, being contracted into the angular mark ∠, and combined with *one*, *two*, or *three* strokes drawn below it, represents *six*, *seven*, or *eight;* and still more abridged and annexed to the sign of four, it denotes *nine*. The distinction of units, tens, hundreds, &c. is indicated by giving the strokes alternately an horizontal and vertical position, while the blanks or vacant bars are expressed by placing small zeros. The very important collection of logarithmic tables just mentioned was printed by the command of the emperor Kang-hi, a man of enlarged views, who governed China with dignity and wisdom during a long course of years. This enlightened prince was much devoted to the learning of Europe, and is reported to have been so fond of calculation as to have those tables abridged and printed in a smaller character, which precious volume he carried constantly fastened to his girdle. The emperor Kien-long, who, after a beneficent reign of 60 years, in the decline of a protracted life spontaneously resigned the imperial office to his son, discovered a similar taste for the mathematical sciences.

Greek numerals.

The Greeks, after having communicated to the founders of Rome the elements of the numeral characters which are still preserved, again exercised their inventive genius in framing new systems of notation. Discarding the simple original strokes, they sought to draw materials of construction from their extended alphabet. They had no fewer than three different modes of proceeding. 1*st*, The letters of the alphabet, in their natural succession, were employed to signify the smaller ordinal numbers. In this way, for instance, the books of Homer's *Iliad* and *Odyssey* are usually marked. But the practice could scarcely be older than the time of Aristotle, who, it is well known, first collected and arranged those immortal poems, in the edition of the *Casket*, for the use of his illustrious pupil Alexander the Great. 2*d*, The first letters of the words for numerals were adopted as abbreviated symbols. Thus, employing capitals only, Ι, being retained as before, to denote *one*, the letter Π of ΠΕΝΤΕ' marked *five*, the Δ of ΔΕΚΑ denoted *ten*, the Η of ῾ΕΚΑΤΟΝ, anciently written HEKATON, expressed *an hundred*, the Χ of ΧΙΛΙΑ *a thousand*, and the letter Μ of the word ΜΥΡΙΑ represented *ten thousand*. A simple and ingenious device was used for augmenting the powers of those symbols; a large Π placed over any letter made it signify *five thousand* times more. Thus, |Δ| denoted *fifty thousand*, and |Η| *five hundred thousand*. See Plate LXXII. 3*d*, But a mighty stride was afterwards made in numerical notation by the Greeks, when they distributed the twenty-four letters of their alphabet into three classes, corresponding to *units*, *tens*, and *hundreds*. To complete the symbols for the nine digits, an additional character was introduced in each class. The mark ς, called *episêmon*, was inserted among the units, immediately after ε, the letter denoting five; and the *koppa* and *sanpi*, represented by S, ϙ, or ϡ terminated respectively the range of *tens* and of *hundreds*, or expressed ninety and nine hundred. This arrangement of the symbols, it is obvious, could extend only to the expression of nine hundred and ninety-nine; but, by subscribing an *iota* under any character, the value was augmented a thousand fold, or by writing the letter Μ, or the mark for a *myriad*, or ten thousand, under it, the effect was increased ten times more. This last modification was sometimes more simply accomplished by placing two dots over the character.

Such is the beautiful system of Greek numerals, so vastly superior in clearness and simplicity to the Roman combination of strokes. It was even tolerably fitted as an instrument of calculation. Hence the Greeks early laid aside the use of the *abacus;* while the Romans, who never showed any taste for science, were confined, by the total inaptitude of their numerical symbols, to the practice of the same laborious manipulation.

It should, however, be remarked, that the Greeks distinguished the theory from the practice of arithmetic, by separate names. The term *Arithmetic* itself was restricted by them to the science which treats of the nature and general properties of numbers; while the appellation *Logistic* was appropriated to the collection of rules framed to direct and facilitate the common operations of calculation. The ancient systems of arithmetic, accordingly, from the books of Euclid to the treatise of Böethius and the verses or commentaries of Capella, are merely speculative, and often abound with fanciful analogies. Pythagoras had brought from the East a passion for the mystical properties of numbers, under the veil of which he probably concealed some of his secret or esoteric doctrines. He regarded *Numbers* as of divine origin, the fountain of existence, and the model and archetype of all things. He divided them into a variety of different classes, to each of which were assigned distinct properties. They were prime or composite, perfect or imperfect, redundant or deficient, plane or solid; they were triangular, square, cubic, or pyramidal. *Even* numbers were held by that visionary philosopher as feminine, and allied to earth; but the *odd* numbers were considered by him as endued with masculine virtue, and partaking of the celestial nature. He esteemed the *unit*, or *monad*, as the most eminently sacred, and as the parent of all scientific numbers; he viewed *two*, or the *duad*, as the associate of the *monad*, and the mother of the elements; and he regarded *three*, or the *triad*, as perfect, being the first of the masculine numbers, comprehending the beginning, middle, and end, and hence fitted to regulate by its combinations the repetition of prayers and libations. As the *monad* represented the Divinity, or the Creative Power, so the *duad* was the image of Matter; and the *triad*, resulting from their mutual conjunction, became the emblem of Ideal Forms.

Mystical properties of numbers.

But the *tetrad*, or *four*, was the number which Pythagoras affected to venerate the most. It is a square, and contains within itself all the musical proportions, and exhibits by summation all the digits as far as ten, the root of the universal scale of numeration; it marks the seasons, the elements, and the successive ages of man; and it likewise represents the cardinal virtues, and the opposite vices. The ancient division of mathematical science into Arithmetic, Geometry, Astronomy, and Music, was fourfold, and the course was therefore termed a *tetractys* or *quaternion*. Hence, Dr Barrow would explain the oath familiar to the disciples of Pythagoras, "I swear by him who communicated the *Tetractys*."

Five, or the *pentad*, being composed of the first male and female numbers, was styled the number of the world. Repeated anyhow by an odd multiple, it always re-appeared; and it marked the animal senses and the zones of the globe.

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Six, or the *hextad*, being composed of its several factors, was reckoned perfect and analogical. It was likewise valued as indicating the sides of the cube, and as entering into the composition of other important numbers.

Seven, or the *heptad*, formed from the junction of the *triad* with the *tetrad*, has been celebrated in every age. Being unproductive, it was dedicated to the virgin Minerva, though possessed of a masculine character. It marked the series of the lunar phases, the number of the planets, and seemed to modify and pervade all nature.

Eight, or the *octad*, being the first cube that occurred, was dedicated to Cybele, the mother of the gods, whose image in the remotest times was only a cubical block of stone.

Nine, or the *ennead*, was esteemed as the square of the *triad*. It denotes the number of the Muses, and, being the last of the series of digits, and terminating the tones of music, it was inscribed to Mars.

Ten, or the *decad*, from the important office which it performs in numeration, was, however, the most celebrated for its properties. Having completed the cycle and begun a new series of numbers, it was aptly styled *apocatastasic* or periodic, and therefore dedicated to the double-faced Janus.

The cube of the *triad*, or the number *twenty-seven*, expressing the time of the moon's periodic revolution, was supposed to signify the power of the lunar circle. The quaternion of celestial numbers, *one, three, five*, and *seven*, joined to that of the terrestrial numbers *two, four, six*, and *eight*, compose the number *thirty-six*, the square of the first perfect number *six*, and the symbol of the universe, distinguished by wonderful properties.

But it would be endless to recount all the visions of the Pythagorean school; nor should we descend to notice such fancies, if, by a perpetual descent, the dreams of ancient philosophers had not, in the actual state of society, still tinctured our language, and mingled with the various institutions of civil life. Not to wander in search of illustration, we see the predilection for the number *seven* strongly marked in the customary term of apprenticeships, in the period required for obtaining academical degrees, and in the legal age of majority.

Numerical fancies of the Chinese.

The Chinese appear, from the remotest epochs of their empire, to have entertained the same admiration of the mystical properties of numbers that Pythagoras imported from the East. Distinguishing numbers into even and odd, they considered the former as terrestrial, and partaking of the feminine principle *Yang;* while they regarded the latter as of celestial extraction, and endued with the masculine principle *Yn*. The even numbers were represented by small black circles, and the odd ones by similar white circles, variously disposed, and connected by straight lines. See Plate LXXII. The sum of the five even numbers *two, four, six, eight*, and *ten*, being *thirty*, was called the number of the *Earth;* but the sum of the five odd numbers *one, three, five, seven*, and *nine*, or *twenty-five*, being the square of *five*, was styled the number of *Heaven*. The nine digits were likewise grouped in two different ways, termed the *Lo-chou* and the *Ho-tou*. The former expression signifies the *Book of the River Lo*, or what the great Yu saw delineated on the back of the mysterious tortoise which rose out of that river: it may be conceived from this arrangement.

	Nine	
Four		*Two*
Three	*Five*	*Seven*
Eight		*Six*
	One	

Nine was reckoned the head, and *one* the tail, of the tortoise; *three* and *seven* were considered as its left and right shoulders; and *four* and *two, eight* and *six*, were viewed as the fore and the hind feet. The number *five*, which represented the heart, was also the emblem of Heaven. We need scarcely observe, that this group of numbers is nothing but the common *magic-square*, each row of which makes up *fifteen*.

As the *Lo-chou* had the figure of a square, so the *Hotou* had that of a cross. It is what the emperor Fou-hi observed on the body of the horse-dragon which he saw spring out of the river Ho. The central number was *ten*, which, it is remarked by the commentators, terminates all the operations on numbers.

		Seven		
		Two		
Five	*Three*	*Ten*	*Four*	*Nine*
		Five		
		One		
		Six		

The Greek system of notation proceeded directly as far as *ten thousand*, comprising four terms of the *Denary Scale;* but by subscribing M, the initial letter of μυϱια, it was carried over another similar period to signify *hundreds of millions*. But the penetrating genius of Archimedes quickly discerned the powers and unfolded the properties of such progressions. In a curious tract, entitled Ψαμμιτης or *Arenarius*, this philosopher amused himself with showing that it was possible, assuming the estimation of Aristarchus of Samos, and other astronomers of that age, to represent the number of particles of sand which would be required to fill the sphere of the universe. He took the limit of the ordinary numeral system, or *ten thousand times ten thousand*, that is, *an hundred millions*, as the root of a new scale of progression, which therefore advanced eight times faster than the simple denary notation. Archimedes proposed to carry this comprehensive system as far as eight periods, which would therefore correspond to a number expressed in our mode by sixty-four digits. From the nature of a geometrical progression, he demonstrated that proportional numbers would range at equal distances, and consequently that the product of any two numbers must have its place determined by the sum of the separate ranks,—a principle which involves the theory of logarithms.

Extended notation proposed by Archimedes,

The fine speculation of the Sicilian philosopher does not, however, appear to have been carried into effect; and without actually performing those calculations, he contents himself by pointing out the process, and stating the approximate results. But Apollonius, the most ingenious and inventive, next to Archimedes, of all the ancient mathematicians, resumed that scheme of numeration, simplified the construction of the scale, and reduced it to a commodious practice. For greater convenience, he preferred the simple myriad as the root of the system, which, therefore, proceeded by successive periods, corresponding to four of our digits. The periods were distinguished by breaks or blanks. That most important office which, in the modern system of notation, the cipher performs, by marking the rank of the digits, was indeed unknown to the earlier Greeks. They were hence obliged, when the lower periods failed, to repeat the letters Μυ. or the contraction for μυϱια, *ten thousand*. Thus, to express *thirty-four trillions*, they wrote λδ Μυ. Μυ. Μυ. To signify *units* separately, it was customary with them to prefix the mark Μ°. or the abbreviation for *monad*.

and by Apollonius.

The procedure of the Greek arithmetician was necessarily slower and more timid than our simple yet refined mode of calculation. Each step in the multiplication of

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complex numbers appeared separate and detached, without any concentration which the moderns obtain, by carrying forward the multiples of ten, and blending together the different members of the product. In ancient Greece, the operations of arithmetic, like writing, advanced from left to right; each part of the multiplier was in succession combined with every part of the multiplicand; and the several products were distinctly noted, or, for the sake of compactness, grouped and conveniently dispersed till afterwards collected into one general amount.

Pappus of Alexandria, in his valuable *Mathematical Collections*, has preserved a set of rules which Apollonius had formed, for facilitating arithmetical operations. These are, in the cautious spirit of the ancient geometry, branched out into no fewer than twenty-seven propositions, though all comprised in the principle formerly stated by Archimedes, That the product of two integers of different ranks will occupy a rank corresponding to the sum of the component orders. Suppose μ were to be multiplied into σ, or *forty* into *two hundred:* Take the lower corresponding characters δ and β, or *four* and *two*, which were called πυθμενες or radicals, the one depressed ten times, and the other an hundred times, and multiply their product η, or *eight*, successively by the ten and the hundred, or at once by a thousand, and the result is $\underset{,}{\eta}$ or *eight thousand.*

Greek mode of calculation.

We shall take an example in multiplication, affording more variety than such as occur in Eutocius, which generally consist in the mere squaring of numbers. Let it be required to multiply *eight hundred* and *sixty-two* by *five hundred* and *twenty-three.* The operation would be performed in this way.

$$\begin{array}{r}
\omega\ \xi\ \beta\quad\quad\quad \\
\varphi\ \varkappa\ \gamma\quad\quad\quad \\
\hline
\ddot{\mu}\ \ddot{\gamma}\ \underset{,}{\alpha}\quad\quad\quad\quad\quad\quad\quad \\
\ddot{\alpha}\ \varsigma\quad\quad\quad\quad\quad\quad\quad \\
\underset{,}{\alpha}\ \sigma\ \mu\quad\quad\quad\quad \\
\underset{,}{\beta}\ \upsilon\quad\quad\quad\quad\quad \\
\varrho\ \pi\ \varsigma\quad\quad\quad \\
\hline
\ddot{\mu}\ \ddot{\varepsilon}\quad \omega\ \varkappa\ \varsigma\quad\quad\quad
\end{array}$$

In the first range, φ multiplied into ω, being the same as the product of *eight* and *five* augmented ten thousand times, is consequently denoted by $\ddot{\mu}$ or $\underset{M}{\mu}$; φ multiplied into ξ gives the same result as *five* times *six* increased a thousand fold, and therefore expressed by $\ddot{\gamma}$ or $\underset{M}{\gamma}$; and φ multiplied into β evidently makes a thousand, or $\underset{,}{\alpha}$. In the second range, $\varkappa$ multiplied into ω gives the same product as *eight* repeated *twice* and then augmented a thousand times, or denoted by $\ddot{\alpha}\,\varsigma$; $\varkappa$ multiplied into ξ is equivalent to *six* repeated *twice*, and afterwards increased an hundred fold or, expressed by $\underset{,}{\alpha}\,\sigma$; and $\varkappa$ multiplied by β gives forty, the value of μ. In the third range, γ multiplied into ω produces twenty-four hundred, which is denoted by $\underset{,}{\beta}\,\upsilon$; γ multiplied into ξ makes an hundred and eighty, or $\varrho\,\pi$; and, lastly, γ multiplied into β gives ς, the symbol for *six.* Collecting the scattered members into one sum, the result of the multiplication of *eight hundred and sixty-two* by *five hundred and twenty-three* is $\ddot{\mu}\ \ddot{\varepsilon}\ \omega\ \varkappa\ \varsigma$, or *four hundred and fifty thousand eight hundred and fifty-six.*

But the Greek notation was not adapted for the descending scale. To express fractions, two distinct methods were followed. 1. If the numerator happened to be unit, the denominator was indicated by an accent. Thus δ' signified *one fourth*, and $\varkappa\varepsilon'$ *one twenty-fifth;* but *one half* being of most frequent recurrence, was signified by a particular character, varying in its form, C, ∠, C', or K. 2. In other cases it was the practice of the Greeks to write the denominator as we do an exponent, a little above the denominator, and towards the right hand. Thus, $\beta^{\iota\alpha}$ intimated *two-elevenths*, and $\pi\alpha^{\varrho\varkappa\alpha}$ *eighty-one*, of *an hundred and twenty-one* parts.

As an illustration of the management of fractions, we select an example somewhat complicated, from the commentary which Eutocius of Ascalon wrote about the third century of our era, on the *Tract of Archimedes* concerning the quadrature of the circle. Let it be required to multiply the mixed number *one thousand* and *thirty-eight* with *nine-elevenths*, by itself.

$$\begin{array}{r}
\underset{,}{\alpha}\ \omega\ \lambda\ \eta\quad \theta^{\iota\alpha}\quad\quad \\
\underset{,}{\alpha}\ \omega\ \lambda\ \eta\quad \theta^{\iota\alpha}\quad\quad \\
\hline
\underset{M}{\varrho}\ \underset{M}{\pi}\ \underset{M}{\gamma}\ \underset{,}{\eta}\ \underset{,}{\omega}\ \varsigma\ \eta\quad \beta^{\iota\alpha}\quad\quad \\
\pi\ \underset{M}{\xi\delta}\ \underset{M}{\beta}\ \underset{,}{\delta}\ \underset{,}{\varsigma}\ \upsilon\ \chi\ \nu\ \delta\quad \varsigma^{\iota\alpha}\quad\quad \\
\underset{M}{\gamma}\ \underset{M}{\beta}\ \underset{,}{\delta}\ ϡ\ \sigma\ \mu\ \varkappa\ \delta\quad \varsigma^{\iota\alpha}\quad\quad \\
\underset{,}{\eta}\ \underset{,}{\varsigma}\ \upsilon\ \sigma\ \mu\ \xi\ \delta\ \varsigma\quad \varsigma^{\iota\alpha}\quad\quad \\
\omega\ \iota\ \eta\quad \beta^{\iota\alpha}\quad\quad \\
\chi\ \nu\ \delta\quad \varsigma^{\iota\alpha}\quad\quad \\
\varkappa\ \delta\quad \varsigma^{\iota\alpha}\quad\quad \\
\varsigma\quad \varsigma^{\iota\alpha}\quad\quad \\
\pi\alpha^{\varrho\varkappa\alpha}\quad \\
\hline
\tau\ \underset{M}{\lambda}\ \eta\quad \underset{,}{\alpha}\ \sigma\ \nu\ \alpha\ \zeta^{\iota\alpha}\ \pi\alpha^{\varrho\varkappa\alpha} \\
\text{or, }\tau\ \underset{M}{\lambda}\ \eta\quad \underset{,}{\alpha}\ \sigma\ \nu\ \beta\ \lambda\zeta^{\varrho\varkappa\alpha}\quad\quad
\end{array}$$

It is to be observed, that, to multiply the several integers by the fraction nine-elevenths, amounts to their multiplication by nine, and the subsequent division by eleven. The excesses being *two* and *six-elevenths*, are denoted by $\beta^{\iota\alpha}$ and $\varsigma^{\iota\alpha}$, while the product of the fraction itself gives *eighty-one* of *an hundred and twenty-one* parts, expressed by $\pi\alpha^{\varrho\varkappa\alpha}$.

But the laborious operations that such complex fractions required were afterwards superseded by the use of *sexagesimals*, which, we have already observed, the astronomers, and especially Ptolemy, had introduced. "The division of the circumference of the circle into three hundred and sixty equal parts or degrees was no doubt originally founded on the supposed length of the year, which, expressed in round numbers, consists of twelve months, each composed of thirty days. The radius approaching to the sixth part of the circumference would contain nearly sixty of those degrees; and after its ratio to the circumference was more accurately determined, the radius still continued to be distinguished into the same number of divisions, which likewise bore the same name. As calcu-

lation now aimed at greater accuracy, each of these sixty divisions of the radius was, following the uniform progression, again subdivided into sixty equal portions called minutes; and, repeating the process of sexagesimal subdivision, seconds and thirds were successively formed. The operations with sexagesimal fractions were performed in the descending scale, on a principle quite similar to that which Archimedes had before laid down. Each period of the multiplier, still proceeding from the left hand, was multiplied into a period of the multiplicand; and this product was then thrown to a rank depressed as much as the descents of both its factors. Thus, minutes multiplied into seconds produced thirds; and seconds multiplied into thirds produced fifths." *Edinburgh Review*, vol. xviii. p. 200.

As an exemplification of this process, we shall take the question proposed by Theon to find the square of the side of a regular decagon inscribed in a circle, or the chord of *thirty-six* degrees, which, according to Ptolemy's computation, measured, in sexagesimal parts of the radius, *thirty-seven* degrees, *four* minutes, and *fifty-five* seconds. The multiplication is thus effected:

λζ	δ	νε		
λζ	δ	νε		
͵ατξθ	ρμη	͵βλε		
	ρμη	ις	σκ	
		͵βλε	σκ	
				͵γκε
͵ατοε	δ	ιδ	ι	κε

Here in the first line, λζ multiplied into λζ in the place of units, gives ͵ατξθ or *thirteen hundred and sixty-nine* degrees; λζ into δ on the next bar, gives ρμη, or *one hundred and forty-eight* minutes; and λζ into νε on the lowest bar gives ͵βλε, or *two thousand and thirty-five* seconds. In the second line δ multiplied into λζ gives the product ρμη as before; δ multiplied into δ, both of them on the bar of minutes, gives ις or *sixteen* seconds; δ into νε gives σκ, or *two hundred and twenty* thirds. Lastly, in the third line the νε on the bar of seconds, multiplied successively into λζ and δ, produce, as before, ͵βλε and σκ on the bars of seconds and thirds; and νε multiplied by itself gives ͵γκε, or *three thousand and twenty-five* fourths. These several products being reduced and collected together, formed the total amount of ͵ατοε δ ιδ ι κε, or *thirteen hundred and seventy-five* degrees, *four* minutes, *fourteen* seconds, *ten* thirds, and *twenty-five* fourths; but all the terms below seconds were omitted in practice as insignificant.

This calculation is laborious and intricate, yet with a very few terms it approaches to a considerable degree of accuracy. One of the most elegant theorems in elementary geometry demonstrates that the side of a regular decagon, inscribed in a circle, is equal to the segment of the radius, divided in extreme and mean ratio. Wherefore the square now computed should be equal to the product of *sixty*, or the radius, into *twenty-two* degrees, *fifty-five* minutes, and *five* seconds, the smaller segment; that is, equal to *thirteen hundred* and *seventy-five* degrees and *five* minutes, from which it differs only by the defect of less than one minute.

The Sexagesimal Arithmetic was, therefore, a most valuable improvement engrafted on the notation of the Greeks. The astronomers of Alexandria and Constantinople continued to employ it in all their calculations, and were afterwards imitated by succeeding observers among the Arabians and Persians. The mode of working sexagesimals had thus become generally known and reduced to practice; but we owe the first distinct treatise on those fractions to a very extraordinary character,—Barlaam, a Calabrian monk, the friend and Greek preceptor of the famous Petrarch, and a man of learning and vigorous intellect, who laboured by his writings and his missions to re-unite the Eastern to the Western church. This adventurous personage, whose wayward conduct and dark features betrayed a lurking ferocity, met with a most singular fate. Being overtaken by a tremendous thunder-storm, while crossing the Adriatic Sea, he lashed himself to the mast of the bark, and was, in this situation, struck dead by a flash of lightning. The event happened in 1348; but Barlaam's tract on sexagesimals, neatly composed in six books, after the strict manner of the ancients, and entitled generally Λογιστικη, or *Computation*, first appeared in a Latin version at Strasburg in 1572, though not published complete with the Greek text until the year 1600, when it was edited at Paris by Chambers of Eton, from a manuscript procured from the Continent by the zeal of Sir Henry Savile.

To facilitate the operations with sexagesimals, it seemed indispensable to have a more extensive multiplication table, that should include the mutual products of all the numbers from one to sixty. This was actually constructed about the middle of the sixteenth century by Philip Lansberg, a Dutch clergyman, and has been exhibited since in various forms by Dr Wallis and others. In the mean time a material change had been effected in the subdivision of the radius of the circle, from which the sexagesimal system had taken its rise. Purbach, the great restorer of mathematical science, instead of making the radius to consist of 216,000 seconds, as Ptolemy and succeeding astronomers had done, stopt short at sixty degrees, and distinguished each of these by a repeated centesimal division, into ten thousand equal parts. Regiomontanus advanced a step farther, and, rejecting the sexagesimal admixture, divided the radius at once into a million of parts, thus following out an arrangement purely decimal. The subdivision into degrees, minutes, and seconds, was henceforth confined to the circumference itself; and when logarithms came afterwards to be adapted to those fractions, they received the appellation, once general, though now restricted, of *Logistic*. But the sexagesimal subdivision had nearly been rejected altogether. Our very meritorious countryman Mr Briggs, in computing his canon of logarithms, followed in another branch the example of Purbach, by distinguishing each degree of the circumference into *an hundred* minutes, and each of these again into *an hundred* seconds; and we cannot help regretting that this easy and obvious improvement had not been generally embraced at the time it was proposed. The French mathematicians have lately gone farther, and endeavoured to pursue to its utmost extent the decimal subdivision first introduced by Regiomontanus. They begin with dividing the quadrant into *an hundred* instead of ninety degrees; and then following the plan of Briggs, they successively divide each degree into *an hundred* minutes, and each minute into *an hundred* seconds. But the advantages which might arise from the adoption of this plan are not sufficient perhaps to outweigh the manifest inconvenience that must attend it in the present advanced state of the science; and notwithstanding the sanguine dreams of some of its projectors, we cannot indulge the expectation of ever seeing it obtain a general and durable currency.

"The Greek arithmetic, then, as successively mould-

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ed by the ingenuity of Archimedes, of Apollonius, and Ptolemy, had attained, on the whole, to a singular degree of perfection, and was capable, notwithstanding its cumbrous structure, of performing operations of very considerable difficulty and magnitude. The great and radical defect of the system consisted in the want of a general mark analogous to our cipher; and which, without having any value itself, should serve to ascertain the rank or power of the other characters, by filling up the vacant places in the scale of numeration. Yet were the Greeks not altogether unacquainted with the use of such a sign; for Ptolemy, in his *Almagest*, employs the small *o* to occupy the accidental blanks which occurred in the notation of sexagesimals. This letter was perhaps chosen by him, because immediately succeeding to *ν*, which denotes 60, it could not, in the sexagesimal arrangement, occasion any sort of ambiguity. But the advantage thence resulting was entirely confined to that particular case. The letters, being already significant, were generally disqualified for the purpose of a mere supplementary notation; and the selection of an alphabetic character to supply the place of the cipher may be considered as an unfortunate circumstance, which appears to have arrested the progress towards a better and more complete system. Had Apollonius classed the numerals by denary triads instead of tetrads, he would have greatly simplified the arrangement, and avoided the confusion arising from the admixture of the punctuated letters expressing thousands. It is by this method of proceeding with periods of three figures, or advancing at once by thousands instead of tens, that we are enabled most expeditiously to read off the largest numbers. The extent of the alphabet was favourable to the first attempts at enumeration; since, with the help of three intercalations, it furnished characters for the whole range below a thousand; but that very circumstance in the end proved a bar to future improvements. It would have been a most important stride to have next exchanged those triads into monads, by discarding the letters expressive of tens and hundreds, and retaining only the first class, which, with its inserted *episêmon*, should denote the nine digits. The *iôta*, which signified ten, now losing its force, might have been employed as a convenient substitute for the cypher. By such progressive changes the arithmetical notation of the Greeks would at last have reached its utmost perfection, and have exactly resembled our own. A wide interval no doubt did still remain; yet the genius of that acute people, had it continued unfettered, would in time, we may presume, have triumphantly passed the intervening boundaries. But the death of Ptolemy was succeeded by ages of languor and decline; and the spirit of discovery insensibly evaporated in miserable polemical disputes, till the fair establishment of Alexandria was finally overwhelmed under the irresistible arms of the Arabs, lately roused to victory and conquest by the enthusiasm of a new religion." (*Edinburgh Review*, vol. xviii. p. 203.)

History of the denary numerals.

The ingenuity and varied resources of the ancient Greeks were the main causes which diverted them from discovering our simple denary system. Having attained a distinct conception of the powers of the geometrical progression, and even advanced so far as to employ their small o to fill the breaks of a period, nothing seemed wanting but to dismiss the punctuated letters, and those for tens and for hundreds, and to retain merely the direct symbols for units, that is, the first third part of their alphabet. Here, however, those masters of science were stopt in their career; and the Eastern Empire presents a melancholy picture of the decline and corruption of human nature. Ingenuity had degenerated into polemical subtlety, and the manly virtues which freedom inspires were exchanged for meanness and self-abasement.

Some writers, misled by very superficial views of the subject, have yet ascribed the invention of the modern numeral characters to the Greeks, or even to the Romans. Both these people, for the sake of expedition, occasionally used contractions, especially in representing the numbers and fractions of weights or measures, which, to a credulous peruser of mutilated inscriptions, or ancient blurred manuscripts, might appear to resemble the forms of our ciphers. But this resemblance is merely casual, and very far indeed from indicating the adoption of a regular denary notation. The most contracted of the Roman writings was formed by the marks attributed to Tiro or Seneca, while that of the Greeks was mixed with the symbols called *Siglæ;* both of which have exercised the patience and skill of antiquaries and diplomatists. In the latter species of characters were kept the accounts of the revenues of the empress Irene at Constantinople. But the modern Greeks appear likewise to have sometimes used a simpler kind of marks, at least for the low numbers. The continuator of Matthew Paris's *History* relates, that "in the year 1251 died John Basingstoke, archdeacon of Leicester, who brought into England the numeral figures of the Greeks, and explained them to his friends." It is subjoined that they consisted of a perpendicular stroke, with a short line inserted at different heights and at different angles, signifying units on the left and tens on the right side. The figures themselves are scrawled on the margin of the text; but they are evidently so different in their form, and so distinct in their nature, from the modern ciphers, that one cannot help feeling surprise to see an author of any discernment refer the introduction of the latter to Basingstoke.

It cannot be doubted that we derived our knowledge of the numeral digits from the Arabians, who had themselves obtained this invaluable acquisition from their extended communication with the East. Those deserving people who, under the name of Moors or Saracens, had for many centuries cultivated Spain, were most ready to acknowledge their obligation to the natives of India, who, according to Alsephadi, a learned Arabian doctor, boasted of three very different inventions—the composition of the *Golaila Wadamna*, or Pilpay's Fables—the game of chess—and the nine digital characters. Still much obscurity hangs over the whole subject. Two distinct inquiries naturally present themselves:—1, At what period did the Arabians first become acquainted with those characters; and, 2, What is the precise epoch when the knowledge of them was imparted to the Christian nations of Europe. We shall take a short review of both these questions.

Proofs of their Indian origin.

1. Gatterer, the late ingenious and very learned Professor of History at Göttingen, in his *Elements of Universal Diplomacy*, maintains that our ciphers were only primordial letters, invented by Taaut or Theut, and known to the ancient Egyptians and Phœnicians, being still distinctly observed, as he asserts, in the inscriptions painted on the coverings of the oldest mummies; and that afterwards, along with other branches of science, they passed to the Oriental nations, among whom they were preserved, till the victorious arms of the Mussulmans penetrated to India, and brought back those precious monuments of genius. But we cannot believe that a contrivance so very simple, and so eminently useful, as that of the nine digits, if once communicated, could ever again be lost or neglected. Pythagoras and Boethius merely contemplated the properties of numbers, and seem not, in their calculations, to have gone beyond the use of the *Abacus*. An early intercourse had no doubt subsisted between the people of Egypt and of India, and a striking resemblance may be traced in their customs, their buildings, and their

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religious rites. But the characters exhibited on the Egyptian monuments bear no indication of the *Denary System*, and are, like the Roman and Chinese numerals, abridged representations of objects, rather than arbitrary signs.

That the occupiers of Hindostan, and the nations communicating with them, have for ages been acquainted with the use of the denary notation, cannot be disputed. But was this an original discovery, or at what distant epoch was it first introduced among them? The easy credulity of European visitors encouraged the Brahmins to set up very lofty pretensions respecting the antiquity of their science. Among other treasures, they boasted the possession, from time immemorial, of an elementary treatise on arithmetic and mensuration, composed in Sanscrit, and called *Lilawati*, of such inestimable value as to be ascribed to the immediate inspiration of heaven. But the researches of our ingenious countrymen in exploring that sacred language of India have dispelled some illusions, and greatly abated the admiration of the public for such eastern learning. From what we have been able to gather, the *Lilawati* is a very short and meagre performance, loaded with a silly preamble and colloquy of the gods. It begins with the numeration by nine digits, and the supplementary cipher or small o, in what are called the *Devanagari* characters; and it contains the common rules of arithmetic, and even the extraction of the square root, as far as two places of figures; but the examples are generally very easy, scarcely forming any part of the text, and only written on the margin with red ink. Of fractions, whether decimal or vulgar, it treats not at all.

The Hindoos pretend that this arithmetical treatise was composed about the year 1185 of the Christian era. The date of a manuscript, however, is always very uncertain. We know, besides, that the oriental transcriber is accustomed to incorporate without scruple such additions in the text as he thinks fit. Nor will any of the criteria which might ascertain the age of a manuscript apply to the eastern writings, where the composition of the paper, the colour of the ink, and the form of the characters, have for ages continued unchanged.

If the exuberant fancy of the Greeks led them far beyond the denary notation, it seems probable that the feebler genius of the Hindoos might just reach that desirable point, without diverging into an excursive flight. Though now familiar with that system, they are still unacquainted with the use of its descending decimal scale; and their management of fractions, accordingly, is said by intelligent judges to be tedious and embarrassed. In Plate LXXII. (on the left hand, and near the bottom), we have given the Sanscrit digits, and have placed over them the numeral elements from which they might be formed. These consist of a succession of simple strokes, variously combined as far as nine. The resemblance to the *Devanagari* characters appears very striking. From these, again, the common Hindoo and the vulgar Bengalee digits are evidently moulded, with only slight alterations of figure. The Birman numerals, which we have copied from Symes's *Embassy to the Kingdom of Ava*, are manifestly of the same origin; only they have a thin, wirey body, being generally written on the palmyra-leaf with the point of a needle.

It appears, from a careful inspection of the manuscripts preserved in the different public libraries of Europe, that the Arabians were not acquainted with the denary numerals before the middle of the thirteenth century of the Christian era. They cultivated the mathematical sciences with ardour, but seldom aspired at original efforts, and generally contented themselves with copying their Grecian masters. The alphabet of the Arabians had been employed for expressing numbers exactly in the same way as that of the Greeks. The letters, in their succession, were sometimes applied to signify the lower of the ordinal numbers; but more generally they were distinguished into three classes, each composed of nine characters, corresponding to units, tens, and hundreds. Though, like most of the Oriental nations, the Arabians write from right to left, yet they followed implicitly the Greek mode of ranging the numerals and performing their calculations. With the same deference they received the other lessons of their great masters, and very seldom hazarded any improvement, unless where industry and patient observation led them incidentally to extend mensuration, and to rectify and enlarge the basis of astronomy.

It seems highly probable, therefore, that the Arabians did not adopt the Indian numerals until a late period, and after the torrent of victory had opened an easy communication with Hindostan. They might derive their information through the medium of the Persians, who spoke a dialect of their language, had embraced the same religion, and were, like them, inflamed by the love of science and the spirit of conquest. The Arabic numerals, accordingly, resemble exceedingly the Persic, which are now current over India, and there esteemed the fashionable characters. But the Persians themselves, though no longer the sovereigns of Hindostan, yet display their superiority over the feeble Gentoos, since they generally fill the offices of the revenue, and have the reputation of being the most expert calculators in the East. It should be observed, however, that, according to Gladwin, these accountants have introduced a peculiar contracted mode of registering very large sums, partly by the numeral characters, and partly by means of symbols formed of abbreviated words. Yet Sir John Chardin relates that the Persians have no proper terms to express numbers beyond a thousand, which they merely repeat, as our young arithmeticians often do, to signify a million or a billion.

The Indian origin of the denary numerals is farther confirmed by the testimony of Maximus Planudes, a monk of Constantinople, who wrote, about the middle of the fourteenth century, a book on practical arithmetic, entitled *Λογιστικη Ινδικη*, or *Ψηφοφορια κατ' Ινδους, ἡ λεγομενη μεγαλη*, that is, "the great Indian mode of calculating." In his introduction he explains concisely the use of the characters in notation. But Planudes appears neither to have received his information directly from India, nor through the medium of the Persians, the nearest neighbours on the eastern confines of the Greek empire. It is most probable that he was made acquainted with those numerals by his intercourse with Europe, having twice visited, on a sort of embassy, the Republic of Venice; for, of two manuscripts preserved in the library of St Mark, the one has the characters of the Arabians, and the other has that variety which was first current in Europe, while neither of them shows the original characters used in Hindostan.

Their introduction into Europe.

2. But the most important inquiry is to ascertain the period at which the knowledge of our present numerals was first spread over Europe. As it certainly had preceded the invention of the art of printing, the difficulty of resolving the question is much increased by the necessity of searching and examining old and often doubtful manuscripts. Some authors would date the introduction of those ciphers as early as the beginning of the eleventh century, while others, with far greater appearance of reason, are disposed to place it 250 years later.

While the thickest darkness brooded over the Christian world, the Arabians, reposing after their brilliant conquests, cultivated with assiduity the learning and science of Greece. If they contributed little from their own

store of genius, they yet preserved and fanned the holy fire. Nor did they affect any concealment, but would freely communicate to their pupils and visitors that precious knowledge which they had so zealously drawn from different quarters. Some of the more aspiring youth in England and France, disgusted with the wretched trifling of the schools, resorted for information to Spain; and having the courage to subdue the rooted abhorrence entertained in that age against infidels, took lessons in philosophy from the accomplished Moors. Among those pilgrims of science, the most celebrated was Gerbert, a monk, born of obscure parents, at Aurillac, in Auvergne, but promoted by his talents successively to the bishoprics of Rheims and of Ravenna, and finally raised to the papal chair, which he filled during the last four years of the tenth century, under the name of Sylvester II. This ardent genius studied arithmetic, geometry, and astronomy among the Saracens; and, on his return to France, charged with various knowledge, he was esteemed a prodigy of learning by his contemporaries. Nor did the malice of rivals fail to represent him as a magician, leagued with the infernal powers. Gerbert wrote largely on arithmetic and geometry, and gave rules for shortening the operations of the *Abacus*, which he likewise termed *Algorismus*. In some manuscripts the numbers are expressed in ciphers; but we are not thence entitled to infer, as many writers have done, that he had actually the merit of introducing those characters into Europe. The context of his discourse will not support such a conclusion. The figures were not, we have seen, still known to the Arabians themselves; and must have long afterwards been inserted in those copies for the convenience of transcribers.

Nor can we safely refer the introduction of Arabic figures to our famous Roger Bacon, whose various attainments and unwearied research after genuine knowledge raised him far above the level of his contemporaries, but who, to the disgrace of his age and country, suffered a sharp persecution and a tedious imprisonment, on the ridiculous charge of practising the redoubted acts of magic. But the writings of Bacon really discover no proofs of his acquaintance with the denary notation; and the fact commonly stated as an irresistible evidence in his favour bears a very different interpretation. An almanack, now preserved in the Bodleian Library at Oxford, and containing numerals in their earliest forms, has, by the credulity of after-times, been, with all other feats and inventions, ascribed of course to the great necromancer. But unluckily this production is marked with the date 1292, the very year on which Bacon, after a lingering illness, expired; and it besides professes to have been calculated for the meridian of Toulouse, and had consequently been imported without doubt from France.[1]

About the same period John of Halifax, named, in the quaint Latinity then used, *Sacro-Bosco*, who had likewise travelled, wrote his treatise *De Sphæra*, in some copies of which the numbers are given in ciphers. But it appears from examination that such abbreviations were introduced by the license of transcribers.

There is little doubt that the Arabic figures were first used by astronomers, and afterwards circulated in the almanacks over Europe. The learned Gerard Vossius places this epoch about the year 1250; but the judicious and most laborious Du Cange thinks that ciphers were unknown before the fourteenth century; and Father Mabillon, whose diplomatic researches are immense, assures us that he very rarely found them in the dates of any writings prior to the year 1400. Kircher, with some air of probability, seeks to refer the introduction of our numerals to the astronomical tables which, after vast labour and expense, were published by the famous Alphonso, king of Castile, in 1252, and again more correctly four years afterwards. But it is suspected that, in the original work, the numbers were expressed in Roman or Saxon characters. Two letters from that enlightened but ill-requited prince, to our Edward I., which are preserved in the Tower of London, have the dates 1272 and 1278 still denoted by those ancient characters.

In the tenth volume of the *Archæologia*, the Rev. Mr North has given a short account of an almanack preserved in the library of Bennet College, Cambridge, and containing a table of eclipses for the cycle between 1330 and 1348. There is prefixed to it a very brief explication of the use of numerals, and the principles of the denary notation; from which we may see how imperfectly the practice of those ciphers was then understood. The figures are of the oldest form, but differ not materially from the present, except that the four has a looped shape, and the five and seven are turned about to the left and to the right. The one, two, three, and four, are likewise, perhaps for elucidation, represented by so many dots thus, . .. ∴ ::; while five, six, seven, and eight, are signified by a semicircle or inverted Ↄ with the addition of corresponding dots—Ↄ. Ↄ: Ↄ∴. Nine is denoted by o; ten by the same character with a dash drawn across it; and twenty, thirty, or forty, by this last symbol repeated.

As a farther evidence of the inaccurate conceptions which prevailed respecting the use of the digits in the fourteenth century, we may refer to the mixture of Saxon and Arabic numerals which was copied from some French manuscripts by Mabillon, as exhibited in Plate LXXII. The Saxon x, signifying ten, is repeatedly combined with the ordinary figures; and xxx, xxxi, are immediately followed by 302, and 303, which must have been therefore intended to signify *thirty-two* and *thirty-three*, the force of the cipher not being still rightly understood. It should be observed, that the Greek *episêmon* or *Fau*, for the number *six*, had come to be represented by a character similar to G. The Saxon dates are taken from the Danish and Norwegian registers, preserved in Suhm's *Northern Collections*.

One of the oldest authentic dates in the numeral characters is that of the year 1375, which appears written by the hand of the famous Petrarch on a copy of St Augustine that had belonged to that distinguished poet and philosopher. The use of those characters had now begun to spread in Europe, but was still confined to men of learning. We have seen a short tract in the German language, entitled *De Algorismo*, and bearing the date 1390, which explained with great brevity the digital notation

[1] Nothing appears to be worse founded than the attempts to represent the elder Bacon in the light of an original inventor. Notwithstanding the obscurity of his writings, it needs but a little criticism to dispel the conceits fomented by national partiality. Friar Bacon advances no claim even to the discovery of gunpowder, which has been so gratuitously ascribed to him. On the contrary, he admits that the boys in his time were acquainted with the use of this substance in fire-works; and he merely pretends, in a sort of anagram, to give a receipt for making it stronger and better than ordinary.

After the chief ingredient in the composition of gunpowder, under the mistaken names of *natron* or *nitrum*, and *saltpetre* or *rock-salt*, had been imported from the East, probably through the intervention of the Crusaders, its disposition to explode in the contact of inflammable matters, if not communicated along with it, could not remain for any time a secret. The explosive force was a very different and a far more important property, which is perhaps rightly attributed to Schwartz, a German monk, who, in the course of his experiments, stumbled on it about the middle of the fourteenth century.

History.

and the elementary rules of arithmetic. What is very remarkable, the characters in their earliest form are ranged thus, 0, 9, 8, 7, 6, 5, 4, 3, 2, 1, from right to left, the order which the Arabians would naturally follow. But it was not very easy to comprehend at first the precise force of the *cipher*, which, insignificant by itself, only serves to determine the rank and value of the other digits. The name, derived from an Arabic word signifying *vacuity*, is sufficiently expressive; yet a sort of mystery, which has imprinted its trace on language, seemed to hang over the practice, for we still speak of *deciphering*, and of *writing in cipher*, in allusion to some dark or concealed art. After the digits had come to supply the place of the Roman numerals, a very considerable time probably elapsed before they were generally adopted in calculation. The modern practice of arithmetic was unknown in England till about the middle of the sixteenth century. But the lower orders, imitating the clerks of a former age, were still accustomed to reckon with their *counters* or *augrym stones*. In Shakspeare's comedy of the *Winter's Tale*, written at the commencement of the seventeenth century, the clown, staggered with a very simple multiplication, exclaims, that he will try it with counters.

Arithmetic was long considered in England as a higher branch of science, and therefore left, like Geometry, to be studied at the university. Most of the public or grammar schools of the south were, on the suppression of the monasteries, erected a little after the Reformation, during the short but auspicious reign of Edward VI. They were accordingly destined by their founders merely for teaching the dead languages; and the too exclusive pursuit of the same system is now one of the greatest defects in the English plan of liberal education.

It cannot be doubted that the calendars composed in France or Germany, and sent to the different religious houses, were the means of dispersing the knowledge of Arabic numerals over Europe. The library of the University of Edinburgh has a very curious almanack, presented to it, with a number of other valuable tracts, by the celebrated Drummond of Hawthornden, beautifully written on vellum, with most of the figures in vermillion. It is calculated especially for the year 1482, but contains the succession of lunar phases for three cycles, 1475, 1494, and 1513, with the visible eclipses of the sun and moon from 1482 to 1530 inclusive. The date of this precious manuscript, which had once belonged to St Mary's Abbey at Cupar in Angus, is easily determined, and we have copied from it the oldest numerals exhibited in Plate LXXII. To these we have subjoined *fac-similes* from Caxton's *Mirrour of the World*, and a wooden cut from Shirwood's *Ludus Arithmomachiæ*, given in Dibdin's *Bibliotheca Spenceriana*.

The college accounts in the English universities were generally kept in the Roman numerals till the early part of the sixteenth century; nor in the parish registers were the Arabic characters adopted before the year 1600. The oldest date which we have met with in Scotland is that of 1490, which occurs in the rent-roll of the diocese of St Andrews; the change from Roman to Arabic numerals occurring, with a corresponding alteration in the form of the writing, near the end of the volume. The old characters in Plate LXXII. are copied from a manuscript history of the Scottish Bishoprics, apparently written about the year 1550.[1] (J. L.)

Notation and Numeration.

II.—OPERATIONS OF ARITHMETIC.

Chap. I.—Notation and Numeration.

The first elements of arithmetic are acquired during our infancy. The idea of *one* is the simplest of any, and is suggested by every single object. *Two* is formed by placing one object near another; *three*, *four*, and every higher number, by adding one continually to the former collection. As we thus advance from lower numbers to higher, we soon perceive that there is no limit to this increasing operation; and that, whatever number of objects be collected together, more may be added, at least in imagination; so that we can never reach the highest possible number, nor approach near it. The idea of numbers, which is first acquired by the observation of sensible objects, is afterwards extended to measures of space and time, affections of the mind, and other immaterial qualities.

Small numbers are most easily apprehended: a child soon knows what *two* and what *three* is, but has not any distinct notion of *seventeen*. Experience removes this difficulty in some degree: as we become accustomed to handle larger collections, we apprehend clearly the number of a dozen or a score; but perhaps could hardly advance to a hundred without the aid of systematic arrangement, which is the art of forming so many units into a class, and so many of these classes into one of a higher kind, and thus advancing through as many ranks of classes as occasion requires. If a boy arrange an hundred stones in one row, he would be tired before he could reckon them; but if he place them in ten rows of ten stones each, he will reckon an hundred with ease; and if he collect ten such parcels, he will reckon a thousand. In this case, ten is the lowest class, a hundred is a class of the second rank, and a thousand is a class of the third rank.

There does not seem to be any number naturally adapted for constituting a class of the lowest or any higher rank, to the exclusion of others. However, as ten has been universally used for this purpose by the Hebrews, Greeks, Romans, and Arabians, and by all nations who have cultivated this science, it is probably the most convenient for general use; but other scales may be assumed, perhaps, on some occasions with superior advantage; and the principles of arithmetic will appear in their full extent, if the student can adapt them to any scale whatever. Thus, if eight were the scale, 6 times 3 would be two classes and two units, and the number 18 would then be represented by 22. If 12 were the scale, 5 times 9 would be three classes and nine units, and 45 would be represented by 39.

Whatever number of units constitutes a class of the lower rank, the same number of each class should make one of the next higher. This is observed in our arithmetic, ten being the universal scale; but it is not regarded in the various kinds of monies, weights, and the like, which do not advance by any universal measure; and much of the difficulty in the practice of arithmetic arises from that irregularity.

[1] For want of attending to these facts, some learned antiquaries have often suffered themselves to be grossly misled. Thus, Mr De Cardonnel, a respectable author, who has given views and short descriptions of the ancient edifices in Scotland, mentions, without marking the smallest doubt or surprise, that the date 1155 appears over the gateway of the ruins of the Castle of St Andrews. But this front was built subsequent to the murder of the detested Cardinal Beaton, by Archibald Hamilton, who likewise there affixed his arms, but who long afterwards, on the capture of Dumbarton Castle, suffered an ignominious death, for his adherence to Queen Mary and the Popish faction. The real date was unquestionably 1555, only the second figure has been almost effaced by time and accident.

Notation and Numeration.

As higher numbers are somewhat difficult to apprehend, we naturally fall on contrivances to fix them in our minds, and render them familiar; but notwithstanding all the expedients we can fall upon, our ideas of high numbers are still imperfect, and generally far short of the reality; and though we can perform any computation with exactness, the answer we obtain is often incompletely apprehended.

It may not be amiss to illustrate, by a few examples, the extent of numbers which are frequently named without being attended to. If a person employed in telling money reckon an hundred pieces in a minute, and continue at work ten hours each day, he will take seventeen days to reckon a million; a thousand men would take 45 years to reckon a billion. If we supposed the whole earth to be as well peopled as Britain, and to have been so from the creation, and that the whole race of mankind had constantly spent their time in telling from a heap consisting of a quadrillion of pieces, they would hardly have yet reckoned the thousandth part of that quantity.

All numbers are represented by the ten following characters.

1	2	3	4	5	6	7	8	9	0
One,	two,	three,	four,	five,	six,	seven,	eight,	nine,	cipher.

The nine first are called *significant figures*, or *digits;* and sometimes represent units, sometimes tens, hundreds, or higher classes. When placed singly, they denote the simple numbers subjoined to the characters; when several are placed together, the first or right-hand figure only is to be taken for its simple value; the second signifies so many tens, the third so many hundreds, and the others so many higher classes, according to the order they stand in. And as it may sometimes be required to express a number consisting of tens, hundreds, or higher classes, without any units or classes of a lower rank annexed, and as this can only be done by figures standing in the second, third, or higher places, while there are none to fill up the lower ones; therefore an additional character or cipher (0) is necessary, which has no signification when placed by itself, but serves to supply the vacant places, and bring the figures to their proper station.

The following table shows the names and divisions of the classes.

8.	Trillions
4	Hundred thousand of billions
3	Ten thousand of billions
7,	Thousand billions
9	Hundred billions
8	Ten billions
2.	Billions
5	Hundred thousand of millions
6	Ten thousand of millions
4,	Thousand millions
7	Hundred millions
3	Ten millions
8.	Millions
9	Hundred thousands
7	Ten thousands
2,	Thousands
6	Hundreds
4	Tens
5.	Units

The first six figures from the right hand are called the *unit period*, the next six the *million period*, after which the *trillion, quadrillion, quintillion, sextillion, septillion, octillion*, and *nonillion* periods follow in their order.

It is proper to divide any number, before we reckon it, into periods and half periods, by different marks. We then begin at the left hand, and read the figures in their order, with the names of their places, from the table. In writing any number, we must be careful to mark the figures in their proper places, and supply the vacant places with ciphers.

Addition.

As there are no possible ways of changing numbers, except by enlarging or diminishing them according to some given rule, it follows that the whole art of arithmetic is comprehended in two operations, *Addition* and *Subtraction.* However, as it is frequently required to add several equal numbers together, or to subtract several equal ones from a greater, till it be exhausted, proper methods have been invented for facilitating the operation in these cases, and distinguished by the names of *Multiplication* and *Division;* and these four rules are the foundation of all arithmetical operations whatever.[1]

As the idea of number is acquired by observing several objects collected, so is that of fractions by observing an object divided into several parts. As we sometimes meet with objects broken into two, three, or more parts, we may consider any or all of these divisions promiscuously, which is done in the doctrine of vulgar fractions. However, since the practice of collecting units into parcels of tens has prevailed universally, it has been found convenient to follow a like method in the consideration of fractions, by dividing each unit into ten equal parts, and each of these into ten smaller parts; and so on. Numbers divided in this manner are called *Decimal Fractions.*

Chap. II.—Addition.

Addition is that operation by which we find the amount of two or more numbers. The method of doing this in simple cases is obvious, as soon as the meaning of number is known, and admits of no illustration. A young learner will begin at one of the numbers, and reckon up as many units separately as there are in the other, and practice will enable him to do it at once. It is impossible, strictly speaking, to add more than two numbers at a time. We must first find the sum of the first and second, then we add the third to that number, and so on. However, as the several sums obtained are easily retained in the memory, it is neither necessary nor usual to mark them down. When the numbers consist of more figures than one, we add the units together, the tens together, and so on. But if the sum of the units exceed ten, or contain ten several times, we add the number of tens it contains to the next column, and only set down the number of units that are over. In like manner we carry the tens of every column to the next higher. And the reason of this is obvious from the value of the places; since an unit, in any higher place, signifies the same thing as ten in the place immediately lower.

Rule.—*Write the numbers distinctly, units under units, tens under tens, and so on. Then reckon the amount of the right-hand column. If it be under ten, mark it down. If it exceed ten, mark the units only, and carry the tens to the next place. In like manner, carry the tens of each column to the next, and mark down the full sum of the left-hand column.*

Example.

```
 346863
 876734
 123467
 314213
 712316
 438987
 279654
-------
3092234
  24433
```

As it is of great consequence in business to perform addition readily and exactly, the learner ought to practise it till it become quite familiar. If the learner can readily add any two digits, he will soon add a digit to a higher number with equal ease. It is only to add the unit place

[1] To abbreviate, it is sometimes convenient to indicate the four operations of arithmetic by the signs +, —, ×, ÷. The first, +, denotes addition; the second, —, indicates subtraction; the third, ×, multiplication; and the fourth, ÷ division. The sign = put between two quantities indicates that they are equal. Accordingly we may write $2 + 3 = 5$; $7 - 3 = 4$; $5 \times 3 = 15$; $14 \div 2 = 7$.

Addition.

of that number to the digit; and if it exceed ten, it raises the amount accordingly. Thus, because 8 and 6 are 14, 48 and 6 are 54. It will be proper to mark down under the sums of each column, in a small hand, the figure that is carried to the next column. This prevents the trouble of going over the whole operation again, in case of interruption or mistake. If you wish to keep the account clean, mark down the sum and figure you carry on a separate paper, and after revising them, transcribe the sum only. After some practice, we ought to acquire the habit of adding two or more figures at one glance. This is particularly useful when two figures which amount to 10, as 6 and 4, or 7 and 3, stand together in the column.

Every operation in arithmetic ought to be revised, to prevent mistakes; and as one is apt to fall into the same mistake, if he revise it in the same manner he performed it, it is proper either to alter the order, or else to trace back the steps by which the operation advanced, which will lead us at last to the number we began with. Every method of proving accounts may be referred to one or other of these heads.

1*st*, Addition may be proved by any of the following methods: Repeat the operation, beginning at the top of the column, if you began at the foot when you wrought it.

2*d*, Divide the account into several parts; add these separately, and then add the sums together. If their amount correspond with the sum of the account when added at once, it may be presumed right. This method is particularly proper when you want to know the sums of the parts as well as that of the whole.

3*d*, Subtract the numbers successively from the sum; if the account be right, you will exhaust it exactly, and find no remainder.

When the given number consists of articles of different value, as pounds, shillings, and pence, or the like, which are called *different denominations*, the operations in arithmetic must be regulated by the value of the articles. We shall give here a few of the most useful tables.

I. *Sterling Money.*	II. *Avoirdupois Weight.*
4 farthings = 1 penny, *marked* d.	16 drams = 1 ounce, oz.
12 pence = 1 shilling, s.	16 ounces = 1 pound, lb.
20 shillings = 1 pound, £.	28 pounds = 1 quarter, qr.
Also 6s. 8d. = 1 noble.	4 quart. = 1 hundredw^{t}, cwt.
12s. = 1 angel.	20 hundredw^{t} = 1 ton, T.
13s. 4d. or two thirds of a pound = 1 merk.	

Scots money is divided in the same manner as sterling, and has one twelfth of its value. A pound Scots is equal to 1s. 8d. sterling, a shilling Scots to a penny sterling, and a penny Scots to a twelfth part of a penny sterling; a merk Scots is two thirds of a pound Scots, or $13\frac{1}{3}$d. sterling.

III. *Troy Weight.*	IV. *Apothecaries' Weight.*
20 mites = 1 grain, gr.	20 grains = 1 scruple, ℈
24 grains = 1 pennyw^{t}, dwt.	3 scruples = 1 dram, ʒ
20 pennyw^{ts} = 1 ounce, oz.	8 drams = 1 ounce, ℥
12 ounces = 1 pound, lib.	12 ounces = 1 pound, ℔

V. *English Dry Measure.*	VI. *Scots Dry Measure.*
2 pints = 1 quart	4 lippies = 1 peck
4 quarts = 1 gallon	4 pecks = 1 firlot
2 gallons = 1 peck	4 firlots = 1 boll
4 pecks = 1 bushel	16 bolls = 1 chalder
8 bushels = 1 quarter	

VII. *English Land Measure.*	VIII. *Scots Land Measure.*
$30\frac{1}{4}$ square yards = 1 pole or perch	36 square ells = 1 fall
40 poles = 1 rood	40 falls = 1 rood
4 roods = 1 acre	4 roods = 1 acre

IX. *Long Measure.*	X. *Time.*
12 inches = 1 foot	60 seconds = 1 minute
3 feet = 1 yard	60 minutes = 1 hour
$5\frac{1}{2}$ yards = 1 pole	24 hours = 1 day
40 poles = 1 furlong	7 days = 1 week
8 furlongs = 1 mile	365 days = 1 year
3 miles = 1 league	52 weeks and 1 day = 1 year

Rule for Compound Addition.—*Arrange like quantities under like, and carry according to the value of the higher place.*

Note 1. When you add a denomination which contains more columns than one, and from which you carry to the higher by 20, 30, or any even number of tens, first add the units of that column, and mark down their sum, carrying the tens to the next column; then add the tens, and carry to the higher denomination, by the number of tens that it contains of the lower. For example, in adding shillings, carry by 10 from the units to the tens, and by 2 from the tens to the pounds.

Note 2. If you do not carry by an even number of tens, first find the complete sum of the lower denomination, then inquire how many of the higher that sum contains, and carry accordingly, and mark the remainder, if any, under the column. For example, if the sum of a column of pence be 43, which is three shillings and sevenpence, mark 7 under the pence column, and carry 3 to that of the shillings.

Note 3. Some add the lower denominations after the following method: when they have reckoned as many as amounts to one of the higher denomination, or upwards, they mark a dot, and begin again with the excess of the number reckoned above the value of the denomination. The number of dots shows how many are carried, and the last reckoned number is placed under the column.

Examples.

Sterling Money.

£	s.	d.
127	13	3
43	5	$10\frac{1}{2}$
806	18	7
190	2	$5\frac{3}{4}$
214	0	3
85	15	$4\frac{1}{2}$
1467	15	$9\frac{3}{4}$

Avoirdupois Weight.

T.	cwt.	qr.	lb.
3	15	2	24
6	3	0	19
5	7	3	26
3	2	2	0
4	3	1	10
1	18	1	12
24	11	0	7

Chap. III.—Subtraction.

Subtraction.

Subtraction is the operation by which we take a lesser number from a greater, and find their difference. It is exactly opposite to addition, and is performed in a like manner, beginning at the greater, and reckoning downwards the units of the lesser. The greater is called the *minuend*, and the lesser the *subtrahend*.

If any figure of the subtrahend be greater than the corresponding figure of the minuend, we add ten to that of the minuend, and having found and marked the difference, we add one to the next place of the subtrahend. This is called *borrowing ten*. The reason will appear, if we consider that, when two numbers are equally increased by adding the same to both, their difference will not be altered. When we proceed as directed above, we add ten to the minuend, and we likewise add one to the higher place of the subtrahend, which is equal to ten of the lower place.

Rule.—*Subtract units from units, tens from tens, and so on. If any figure of the subtrahend be greater than the corresponding one of the minuend, borrow ten.*

Example.		
Minuend	173694	738641
Subtrahend	21453	379235
Remainder	152241	359406

Subtraction.

To prove subtraction, add the subtrahend and remainder together; if their sum be equal to the minuend, the account is right.

Or subtract the remainder from the minuend. If the difference be equal to the subtrahend, the account is right.

Rule for Compound Subtraction.—*Place like denominations under like; and borrow, when necessary, according to the value of the higher place.*

Examples.

£	s.	d.	Cwt.	qr.	lib.	A.	R.	F	E.
146	3	3	12	3	19	15	2	24	18
58	7	6	4	3	24	12	2	36	7
87	15	9	7	3	23	2	3	28	11

Note 1. The reason for borrowing is the same as in simple subtraction. Thus, in subtracting pence, we add 12 pence when necessary to the minuend, and at the next step we add one shilling to the subtrahend.

Note 2. When there are two places in the same denomination, if the next higher contain exactly so many tens, it is best to subtract the units first, borrowing ten when necessary; and then subtract the tens, borrowing, if there is occasion, according to the number of tens in the higher denomination.

Note 3. If the value of the higher denomination be not an even number of tens, subtract the units and tens at once, borrowing according to the value of the higher denomination.

Note 4. Some choose to subtract the place in the subtrahend, when it exceeds that of the minuend, from the value of the higher denomination, and add the minuend to the difference. This is only a different order of proceeding, and gives the same answer.

Multiplication.

Note 5. As custom has established the method of placing the subtrahend under the minuend, we follow it when there is no reason for doing otherwise; the minuend may be placed under the subtrahend with equal propriety; and the learner should be able to work it either way with equal readiness, as this last is sometimes more convenient, of which instances will occur afterwards.

Note 6. The learner should also acquire the habit, when two numbers are marked down, of placing such a number under the lesser, that, when added together, the sum may be equal to the greater. The operation is the same as subtraction, though conceived in a different manner, and is useful in balancing accounts and on other occasions.

Chap. IV.—Multiplication.

In multiplication two numbers are given, and it is required to find how much the first amounts to when reckoned as many times as there are units in the second. Thus, 8 multiplied by 5, or 5 times 8, is 40. The given numbers (8 and 5) are called *factors*, the first (8) the *multiplicand*, the second (5) the *multiplier*, and the amount (40) the *product*.

This operation is nothing else than addition of the same number several times repeated. If we mark 8 five times under each other, and add them, the sum is 40. But as this kind of addition is of frequent and extensive use, in order to shorten the operation, we mark down the number only once, and conceive it to be repeated as often as there are units in the multiplier.

For this purpose the learner must be thoroughly acquainted with the following multiplication table, which is composed by adding each digit twelve times.

Twice		Thrice		Four times		Five times		Six times		Seven times		Eight times		Nine times		Ten times		Eleven times		Twelve times	
1 is	2	1 is	3	1 is	4	1 is	5	1 is	6	1 is	7	1 is	8	1 is	9	1 is	10	1 is	11	1 is	12
2	4	2	6	2	8	2	10	2	12	2	14	2	16	2	18	2	20	2	22	2	24
3	6	3	9	3	12	3	15	3	18	3	21	3	24	3	27	3	30	3	33	3	36
4	8	4	12	4	16	4	20	4	24	4	28	4	32	4	36	4	40	4	44	4	48
5	10	5	15	5	20	5	25	5	30	5	35	5	40	5	45	5	50	5	55	5	60
6	12	6	18	6	24	6	30	6	36	6	42	6	48	6	54	6	60	6	66	6	72
7	14	7	21	7	28	7	35	7	42	7	49	7	56	7	63	7	70	7	77	7	84
8	16	8	24	8	32	8	40	8	48	8	56	8	64	8	72	8	80	8	88	8	96
9	18	9	27	9	36	9	45	9	54	9	63	9	72	9	81	9	90	9	99	9	108
10	20	10	30	10	40	10	50	10	60	10	70	10	80	10	90	10	100	10	110	10	120
11	22	11	33	11	44	11	55	11	66	11	77	11	88	11	99	11	110	11	121	11	132
12	24	12	36	12	48	12	60	12	72	12	84	12	96	12	108	12	120	12	132	12	144

If both factors be under 12, the table exhibits the product at once. If the multiplier only be under 12, we begin at the unit place and multiply the figures in their order, carrying the tens to the higher place, as in addition.

Ex. 76859 multiplied by 4, or 76859 added 4 times.

$$\begin{array}{r} 76859 \\ 4 \\ \hline 307436 \end{array} \qquad \begin{array}{r} 76859 \\ 76859 \\ 76859 \\ 76859 \\ \hline 307436 \end{array}$$

If the multiplier be 10, we annex a cipher to the multiplicand; if the multiplier be 100, we annex two ciphers, and so on. The reason is obvious, from the use of ciphers in notation.

If the multiplier be any digit, with one or more ciphers on the right hand, we multiply by the figure, and annex an equal number of ciphers to the product. Thus, if it be required to multiply by 50, we first multiply by 5, and then annex a cipher. It is the same thing as to add the multiplicand 50 times; and this might be done by writing the account at large, dividing the column into 10 parts of 5 lines, finding the sum of each part, and adding these ten sums together.

If the multiplier consists of several significant figures, we multiply separately by each, and add the products. It is the same as if we divided a long account of addition into parts corresponding to the figures of the multiplier.

Example. To multiply 7329 by 365.

$$\begin{array}{r} 7329 \\ 5 \\ \hline 36645 \end{array} \qquad \begin{array}{r} 7329 \\ 60 \\ \hline 439740 \end{array} \qquad \begin{array}{r} 7329 \\ 300 \\ \hline 2198700 \end{array} \qquad \begin{array}{rl} 36645 = & 5 \text{ times.} \\ 439740 = & 60 \text{ times.} \\ 2198700 = & 300 \text{ times.} \\ \hline 2675085 = & 365 \text{ times.} \end{array}$$

It is obvious that 5 times the multiplicand added to 60 times, and to 300 times the same, must amount to the product required. In practice we place the products at once under each other; and as the ciphers arising from the higher places of the multiplier are lost in the addition, we omit them. Hence may be inferred the following

Multiplication.

Rule.—*Place the multiplier under the multiplicand, and multiply the latter successively by the significant figures of the former, placing the right-hand figure of each product under the figure of the multiplier from which it arises, then add the product.*

Ex.				
	7329	42785	37846	93956
	365	91	235	8704
	36645	42785	189230	375824
	43974	385065	113538	657692
	21987	3893435	75692	751648
	2675085		8893810	817793024

A number which cannot be produced by the multiplication of two others is called a *prime number;* as 3, 5, 7, 11, and many others.

A number which may be produced by the multiplication of two or more smaller ones, is called a *composite number;* for example, 27, which arises from the multiplication of 9 by 3; and these numbers, 9 and 3, are called the *component parts* of 27.

Contractions and Varieties in Multiplication.

1*st,* If the multiplier be a composite number, we may multiply successively by the component parts.

Ex.	7638 by 45, or 5 times 9	7638
	45	9
	38190	68742
	30552	5
	343710	343710

Because the second product is equal to five times the first, and the first is equal to nine times the multiplicand, it is obvious that the second product must be five times nine, or forty-five times as great as the multiplicand.

2*dly,* If the multiplier be 5, which is the half of 10, we may annex a cipher and divide by 2. If it be 25, which is the fourth part of 100, we may annex two ciphers and divide by 4. Other contractions of the like kind will readily occur to the learner.

3*dly,* To multiply by 9, which is one less than 10, we may annex a cipher, and subtract the multiplicand from the number it composes. To multiply by 99999, or any number of 9's, annex as many ciphers, and subtract the multiplicand. The reason is obvious; and a like rule may be found though the unit place be different from 9.

4*thly,* Sometimes a line of the product is more easily obtained from a former line of the same than from the multiplicand.

Ex. 1*st.*	1372	2*d.*	1348
	84		36
	5488		8088
	10976		4044
	115248		48528

In the first example, instead of multiplying by 8, we may multiply 5488 by 2; and, in the second, instead of multiplying by 3, we may divide 8088 by 2.

5*thly,* Sometimes the product of two or more figures may be obtained at once, from the product of a figure already found.

Ex. 1*st.*	14356	2*d.*	3462321
	648		96484
	114848		13849284
	918784		166191408
	9302688		332382816
			334058579364

In the second example we multiply first by 4, then, because 12 times 4 is 48, we multiply the first line of the product by 12, instead of multiplying separately by 8 and 4; lastly, because twice 48 is 96, we multiply the second line of the product by 2, instead of multiplying separately by 6 and 9.

When we follow this method, we must be careful to place the right-hand figure of each product under the right-hand figure of that part of the multiplier which it is derived from.

It would answer equally well in all cases to begin the work at the highest place of the multiplier; and contractions are sometimes obtained by following that order.

Ex. 1*st.*	3125	or	3125	2*d.*	32452
	642		642		52575
	18750		18750		162260
	12500		131250		811300
	6250		2006250		2433900
	2006250				1706163900

It is a matter of indifference which of the factors be used as the multiplier; for 4 multiplied by 3 gives the same product as 3 multiplied by 4; and the like holds universally true. To illustrate this, we may make three rows of points, four in each row, placing the rows under each other; and we shall have also four rows containing three points each, if we reckon the rows downwards.

. . . .
. . . .
. . . .

Multiplication is proved by repeating the operation, using the multiplier for the multiplicand, and the multiplicand for the multiplier. It may also be proven by division, or by casting out the 9's, of which afterwards; and an account, wrought by any contraction, may be proven by performing the operation at large, or by a different contraction.

Compound Multiplication.

Rule I.—*If the multiplier do not exceed* 12, *the operation is performed at once, beginning at the lowest place, and carrying according to the value of the place.*

Examples.

£	s.	d.	Cwt.	qr.	lb.	A.	R.	P.	Lb.	oz.	dwt.
13	6	7	12	2	8	13	3	18	7	5	9
		9			5			6			12
119	19	3	62	3	12	83	0	28	89	5	8

Rule II.—*If the multiplier be a composite number, whose component parts do not exceed* 12, *multiply first by one of these parts, then multiply the product by the other. Proceed in the same manner if there be more than two.*

Ex. 1*st.*	£15	3	8	by 32 = 8 × 4
			8	
	£121	9	4	= 8 times.
			4	
	£485	17	4	= 32 times.
2*d.*	£17	3	8	by 75 = 5 × 5 × 3
			3	
	£51	11	–	= 3 times.
			5	
	£257	15	–	= 15 times.
			5	
	£1288	15	–	= 75 times.

Note 1. Although the component parts will answer in any order, it is best, when it can be done, to take them in such order as may clear off some of the lower places at the first multiplication, as is done in *Ex.* 2*d.*

Note 2. The operation may be proved by taking the

Reduction. component parts in a different order, or dividing the multiplier in a different manner.

Rule III.—*If the multiplier be a prime number, multiply first by the composite number next lower, then by the difference, and add the products.*

£	s.	d.	
£35	17	9	by 67 = 64+3
		8	64 = 8×8
£287	2	–	= 8 times.
		8	
£2296	16	–	= 64 times.
107	13	3	= 3 times.
£2404	9	3	= 67 times.

Here, because 8 times 8 is 64, we multiply twice by 8, which gives £2296. 16s. equal to 64 times the multiplicand: then we find the amount of 3 times the multiplicand, which is £107. 13s. 3d.; and it is evident that these added amount to 67 times the multiplicand.

Rule IV.—*If there be a composite number a little above the multiplier, we may multiply by that number, and by the difference, and subtract the second product from the first.*

£	s.	d.	
£17	4	5	by 106 = 108 — 2
		12	108 = 9 × 12
£206	13	–	
		9	
£1859	17	–	= 108 times.
34	8	10	= 2 times.
£1825	8	2	= 106 times.

Here we multiply by 12 and 9, the component parts of 108, and obtain a product of £1859. 17s. equal to 108 times the multiplicand; and, as this is twice oftener than was required, we subtract the multiplicand doubled, and the remainder is the number sought.

Rule V.—*If the multiplier be large, multiply by* 10, *and multiply the product again by* 10; *by which means you obtain an hundred times the given number. If the multiplier exceed* 1000, *multiply by* 10 *again; and continue it farther if the multiplier require it; then multiply the given number by the unit-place of the multiplier; the first product by the ten-place, the second product by the hundred-place, and so on. Add the products thus obtained together.*

	£34	8	2¼ by 5 =	£172	1	0¼	=	5 times.
			10					
10 times	£344	2	1 by 6 =	2064	12	6	=	60 times.
			10					
100 times	£3441	–	10 by 4 =	13764	3	4	=	400 times.
			10					
1000 times	£34410	8	4 by 3 =	103231	5	–	=	3000 times.
				£119232	1	10¼	=	3465 times.

The use of multiplication is to compute the amount of any number of equal articles, either in respect of measure, weight, value, or any other consideration. The multiplicand expresses how much is to be reckoned for each article, and the multiplier expresses how many times that is to be reckoned. As the multiplier points out the number of articles to be added, it is always an abstract number, and has no reference to any value or measure whatever. It is therefore quite improper to attempt the multiplication of shillings by shillings, or to consider the multiplier as expressive of any denomination.

Reduction.

Reduction is the computation for changing any sum of money, weight, or measure, into a different kind. When the quantity given is expressed in different denominations, we reduce the highest to the next lower, and add thereto the given number of that denomination; and proceed in like manner till we have reduced it to the lowest denomination.

Division.

Ex. To reduce £46. 13s. 8¾d. to farthings.

£46	
20	
920	shillings in £46
13	
933	shillings in £46 13
12	
11196	pence in £46 13
8	
11204	pence in £46 13 8
4	
44816	farthings in £46 13 8
3	
44819	farthings in £46 13 8¾

Or thus:

£46 13 8¾.
20
933
12
11204
4
44819

It is easy to take in or add the lower denomination at the same time that we multiply the higher.

Chap. V.—Division.

In division two numbers are given, and it is required to find how often the former contains the latter. Thus, it may be asked how often 21 contains 7, and the answer is exactly 3 times. The former given number (21) is called the *dividend*, the latter (7) the *divisor*, and the number required (3) the *quotient*. It frequently happens that the division cannot be completed exactly without fractions. Thus it may be asked, how often 8 is contained in 19? the answer is twice, and the remainder of 3.

This operation consists in subtracting the divisor from the dividend, and again from the remainder, as often as it can be done, and reckoning the number of subtractions; as,

21	19
7 first subtraction	8 first subtraction
14	11
7 second subtraction	8 second subtraction
7	3 remainder.
7 third subtraction.	
0	

As this operation, performed at large, would be very tedious when the quotient is a high number, it is proper to shorten it by every convenient method; and for this purpose we may multiply the divisor by any number whose product is not greater than the dividend, and so subtract it twice or thrice, or oftener, at the same time. The best way is to multiply it by the greatest number that does not raise the product too high, and that number is also the quotient. For example, to divide 45 by 7, we inquire what is the greatest multiplier for 7 that does not give a product above 45, and we shall find that it is 6; and 6 times 7 is 42, which, subtracted from 45, leaves a remainder of 3. Therefore 7 may be subtracted 6 times from 45; or, which is the same thing, 45 divided by 7, gives a quotient of 6 and a remainder of three.

If the divisor do not exceed 12, we readily find the highest multiplier that can be used from the multiplication table. If it exceed 12, we may try any multiplier that we think will answer. If the product be greater than the dividend, the multiplier is too great; and if the remainder, after the product is subtracted from the dividend, be greater than the divisor, the multiplier is too small. In either of these cases we must try another. But the attentive learner, after some practice, will generally hit on the right multiplier at first.

If the divisor be contained oftener than ten times in the dividend, the operation requires as many steps as

there are figures in the quotient. For instance, if the quotient be greater than 100, but less than 1000, it requires 3 steps. We first inquire how many hundred times the divisor is contained in the dividend, and subtract the amount of these hundreds. Then we inquire how often it is contained ten times in the remainder, and subtract the amount of these tens. Lastly, we inquire how many single times it is contained in the remainder. The method of proceeding will appear from the following example:

To divide 5936 by 8.

```
          From  5936
          Take  5600 = 700 times 8.
                ----
          Rem.   336
From which take  320 =  40 times 8.
                ----
          Rem.    16
From which take   16 =   2 times 8.
                ----    ---
                   0    742 times 8 in all.
```

It is obvious, that as often as 8 is contained in 59, so many hundred times it will be contained in 5900, or in 5936; and as often as it is contained in 33, so many ten times it will be contained in 330, or in 336; and thus the higher places of the quotient will be obtained with equal ease as the lower. The operation might be performed by subtracting 8 continually from the dividend, which will lead to the same conclusion by a very tedious process. After 700 subtractions, the remainder would be 336; after 40 more it would be 16; and after 2 more the dividend would be entirely exhausted. In practice we omit the ciphers, and proceed by the following

RULES.—1. *Assume as many figures on the left hand of the dividend as contain the divisor once or oftener; find how many times they contain it, and place the answer as the highest figure of the quotient.*

2. *Multiply the divisor by the figure you have found, and place the product under the part of the dividend from which it is obtained.*

3. *Subtract the product from the figures above it.*

4. *Bring down the next figure of the dividend to the remainder, and divide the number it makes up as before.*

Examples.] 1*st,*

```
8)5936(742
  56··
  --
   33
   32
   --
    16
    16
```

2*d,*

```
63)30114(478
   252··
   ---
    491
    441
    ---
     504
     504
     ---
```

3*d,*

```
365)974932(2671 17/365
    730···
    ---
    2449
    2190
    ----
     2593
     2555
     ----
       382
       365
       ---
Remainder 17
```

The numbers which we divide, as 59, 33, and 16, in the first example, are called *dividuals.*

It is usual to mark a point under the figures of the dividend as they are brought down, to prevent mistakes.

If there be a remainder, the division is completed by a vulgar fraction, whose numerator is the remainder, and its denominator the divisor. Thus, in Ex. 3 the quotient is 2671, and the remainder 17; and the quotient completed is 2671 $\frac{17}{365}$.

A number which divides another without a remainder is said to measure it; and the several numbers which measure another are called its *aliquot parts.* Thus 2, 4, 6, 8, and 12, are aliquot parts of 24. As it is often useful to discover numbers which measure others, we may observe,

1*st,* Every number ending with an even figure, that is, with 2, 4, 6, 8, or 0, is measured by 2.

2*dly,* Every number ending with 5 or 0 is measured by 5.

3*dly,* Every number whose figures, when added, amount to an even number of 3's or 9's, is measured by 3 or 9, respectively.

Contractions and Varieties in Division.

1*st,* When the divisor does not exceed 12, the whole computation may be performed without setting down any figures except the quotient.

Ex. 7)35868(5124 or

```
7)35868
  -----
   5124
```

2*dly,* When the divisor is a composite number, and one of the component parts also measures the dividend, we may divide successively by the component parts.

Ex. 1*st,*] 30114 by 63

```
         9)30114
         7) 3346
Quotient     478
```

2*d,*] 975 by 105 = 5 × 7 × 3

```
         5)975
         3)195
         7) 65
Quotient    9 2/7
```

This method might be also used although the component parts of the divisor do not measure the dividend; but the management of the remainder requires the doctrine of vulgar fractions.

3*dly,* When there are ciphers annexed to the divisor, cut them off, and cut off an equal number of figures from the dividend; annex those figures to the remainder.

Ex. To divide 378643 by 5200.

```
52|00)3786|43(724 4243/5200.
      364·
      ---
       146
       104
       ----
       4243
```

The reason will appear by performing the operation at large, and comparing the steps.

To divide by 10, 100, 1000, or the like: Cut off as many figures on the right hand of the dividend as there are ciphers in the divisor. The figures which remain on the left hand compose the quotient, and the figures cut off compose the remainder.

Note.—Since 4 times 25 make 100, instead of dividing by 25, we may multiply the dividend by 4, and cut off the two last figures from the product. The figures left will be the quotient, and those cut off the remainder. In like manner, to divide by 125, which multiplied by 8 produces 1000, we may multiply the dividend by 8, and cut off three figures, which will be the remainder, and those left the quotient.

4*thly,* When the divisor consists of several figures, we may try them separately, by inquiring how often the first figure of the divisor is contained in the first figure of the dividend, and then considering whether the second and following figures of the divisor be contained as often in the corresponding ones of the dividend with the remainder (if any) prefixed. If not, we must begin again, and make trial of a lower number. When the remainder is nine or upwards, we may be sure the division will hold through the lower places; and it is unnecessary to continue the trial farther.

5*thly,* We may make a table of the products of the divisor, multiplied by the nine digits, in order to discover more readily how often it is contained in each dividual. This is convenient when the dividend is very long, or when it is required to divide frequently by the same divisor.

```
73 by 2 = 146        73)53872694(737982
      3 = 219           511·····
      4 = 292           ---
      5 = 365            277
      6 = 438            219
      7 = 511            ---
      8 = 584             582
      9 = 657             511
                          ---
                           716
                           657
                           ---
                            599
                            584
                            ---
                             154
                             146
                             ---
                     Rem.      8
```

6*thly*, To divide by 9, 99, 999, or any number of 9's, transcribe under the dividend part of the same, shifting the highest figure as many places to the right hand as there are 9's in the divisor. Transcribe it again, with the like change of place, as often as the length of the dividend admits; add these together, and cut off as many figures from the right hand of the sum as there are 9's in the divisor. The figures which remain on the left hand compose the quotient, and those cut off the remainder.

If there be any carriage to the unit place of the quotient, add the number carried likewise to the remainder, as in Ex. 2; and if the figures cut off be all 9's, add 1 to the quotient, and there is no remainder.

```
Ex. 1st,  99)324123              2d,   99)547825
               3241                        5478
                 32                          54
             -------                     -------
             3273|96                     5533|57
   Quotient  3273 and rem. 96.                 1
                                         -------
                               Quotient 5533·58 rem.

              3d,  999)476523
                          476
                      -------
                      476|999
                        1
                      -------
             Quotient 477
```

To explain the reason of this, we must recollect, that whatever number of hundreds any dividend contains, it contains an equal number of 99's, together with an equal number of units. In Ex. 1, the dividend contains 3241 hundreds, and a remainder of 23. It therefore contains 3241 times 99, and also 3241, besides the remainder already mentioned.—Again, 3241 contains 32 hundreds and a remainder of 41. It therefore contains 32 99's, and also 32, besides the remainder of 41. Consequently the dividend contains 99, altogether, 3241 times and 32 times, that is, 3273 times, and the remainder consists of 23, 41, and 32, added, which make 96.

As multiplication supplies the place of frequent additions, and division of frequent subtractions, they are only repetitions and contractions of the simple rules; and, when compared together, their tendency is exactly opposite. As numbers, increased by addition, are diminished and brought back to their original quantity by subtraction; in like manner numbers compounded by multiplication are reduced by division to the parts from which they were compounded. The multiplier shows how many additions are necessary to produce the number; and the quotient shows how many subtractions are necessary to exhaust it. It follows that the product, divided by the multiplicand, will quote the multiplier; and because either factor may be assumed for the multiplicand, therefore the product divided by either factor quotes the other. It follows, also, that the dividend is equal to the product of the divisor and quotient multiplied together; and hence these operations mutually prove each other.

To prove multiplication: Divide the product by either factor. If the operation be right, the quotient is the other factor, and there is no remainder.

To prove division: Multiply the divisor and quotient together; to the product add the remainder, if any; and, if the operation be right, it makes up the dividend. Otherwise divide the dividend (after subtracting the remainder, if any) by the quotient. If the operation be right, it will quote the divisor. The reason of all those rules may be collected from the last paragraph.

Compound Division.

Rule I.—*When the dividend only consists of different denominations, divide the higher denomination, and reduce the remainder to the next lower, taking in* (p. 587, Reduction) *the given number of that denomination, and continue the division.*

Examples.

```
Divide £465. 12s. 8d.            Divide 345 cwt. 1 qr. 8 lb.
  by 72.                           by 22.
   £    s. d.    £ s. d.               Cwt. q. lb.  Cwt. q. lb.
72)465 12 8    (6 9 4              22)345  1  8   (15  2  22
   432 · · ·                          22 · · ·
   ---                                ---
    33                                125
    20                                110
   ---                                ---
72)672                                 15
   648                                  4
   ---                                ---
    24                             22)61
    12                                44
   ---                                ---
72)296                                17
   288                               ·28
   ---                                ---
     8 Rem.                           144
                                       34
                                      ---
Or we might divide by              22)484
the component parts of                44
72 as explained under                 ---
(2dly, p. 588).                        44
                                       44
                                      ---
```

Rule II.—*When the divisor is in different denominations, reduce both divisor and dividend to the lowest denomination, and proceed as in simple division. The quotient is an abstract number.*

```
To divide £38. 13s. by           To divide 96 cwt. 1 qr. 20 lb.
  £3. 4s. 5d.                      by 3 cwt. 2 qr. 8 lb.
                                   Cwt. q. lb.  Cwt. q. lb.
£3  4  5     £38 13                 3  2  8 )  96  1  20
20              20                     4          4
--             ---                   ---        ---
64             773                    14        385
12              12                    28         28
--             ---                   ---        ---
773         )9276(12 quot.           120       3100
             773                      28        770
             ----                    ---       ----
             1546                   4|00      )108|00(27 quot.
             1546
             ----
```

It is best not to reduce the terms lower than is necessary to render them equal. For instance, if each of them consists of an even number of sixpences, fourpences, or the like, we reduce them to sixpences or fourpences, but not to pence.

The use of division is to find either of the factors by whose multiplication a given number is produced when the other factor is given, and therefore is of two kinds, since either the multiplier or the multiplicand may be

given. If the former be given, it discovers what that number is which is contained so many times in another. If the latter be given, it discovers how many times one number is contained in another. Thus, it answers the questions of an opposite kind to those mentioned under Rule V. p. 587, as, to find the quantity of a single parcel or share; to find the value, weight, or measure, of a single article; to find how much work is done, provisions consumed, interest incurred, or the like, in a single day, &c.

The last use of division is a kind of reduction exactly opposite to that described under Rule V. p. 587. The manner of conducting and arranging it, when there are several denominations in the question, will appear from the following examples.

1. To reduce 15783 pence to pounds, shillings, and pence.

```
          20
12)15783(1315(65
   12···  120·
   ──     ───
    37    115
    36    100
    ──    ───
     18    15
     12
     ──
      63
      60
      ──
       3
```

Answer, £65. 15s. 3d.

2. To reduce 174865 grs. to lbs. oz. and dwt. Troy.

```
               20   12
24)174865(7286(364(30
   168···  60··  36·
   ───     ──    ──
     68    128   04
     48    120
     ──    ───
     206    86
     192    80
     ───    ──
     145     6
     144
     ───
       1
```

Ans. 30 lb. 4 oz. 6 dwt. 1 gr.

In the first example we reduce 15783 pence to shillings, by dividing by 12, and obtain 1315 shillings, and a remainder of 3 pence. Then we reduce 1315 shillings to pounds by dividing by 20, and obtain 65 pounds and a remainder of 15 shillings. The divisions might have been contracted.

In the practice of arithmetic questions often occur which require both multiplication and division to resolve. This happens in reduction, when the higher denomination does not contain an exact number of the lower.

Rule for Mixed Reduction.—*Reduce the given denomination by multiplication to some lower one which is an aliquot part of both; then reduce that by division to the denomination required.*

Ex.—Reduce £31742 to guineas.

```
   31742
      20
   ─────
21)634840(30230
   63····
   ───
    048
     42
     ──
      64
      63
      ──
      10
```

Here we multiply by 20, which reduces the pounds to shillings, and divide the product by 21, which reduces the shillings to guineas.

Answer, 30230 guineas and 10 shillings.

Note 1. Guineas may be reduced to pounds by adding one twentieth part of the number.

2. Pounds may be reduced to merks by adding one half.

3. Merks may be reduced to pounds by subtracting one third.

Another case which requires both multiplication and division is, when the value, weight, measure, or duration of any quantity is given, and the value, &c. of a different quantity required, we first find the value, &c. of a single article by division, and then the value, &c. of the quantity required, by multiplication.

Ex. If 3 yards cost 15s. 9d. what will 7 yards cost at the same rate?

```
       s.  d.
3)     15  9 price of 3 yards.
        5  3 price of 1 yard.
           7
   ─────────
 £1    16  9 price of 7 yards.
```

Many other instances might be adduced where the operation and the reasons of it are equally obvious. These are generally, though unnecessarily, referred to the rule of proportion.

We shall now offer a general observation on all the operations in arithmetic. When a computation requires several steps, we obtain a just answer, whatever order we follow. Some arrangements may be preferable to others in point of ease, but all of them lead to the same conclusion. In addition or subtraction we may take the articles in any order, as is evident from the idea of number; or we may collect them into several sums, and add or subtract these either separately or together. When both the simple operations are required to be repeated, we may either complete one of them first, or may introduce them promiscuously; and the compound operations admit of the same variety. When several numbers are to be multiplied together, we may take the factors in any order, or we may arrange them into several classes, find the product of each class, and then multiply the products together. When a number is to be divided by several others we may take the divisors in any order, or we may multiply them into each other, and divide by the product; or we may multiply them into several parcels, and divide by the products successively. Lastly, When multiplication and division are both required, we may begin with either; and when both are repeatedly necessary, we may collect the multipliers into one product and the divisors into another, or we may collect them into parcels, or use them singly, and that in any order. Still we shall obtain the proper answer if none of the terms be neglected.

When both multiplication and division are necessary to obtain the answer of a question, it is generally best to begin with the multiplication, as this order keeps the account as clear as possible from fractions. The example last given may be wrought accordingly as follows:

```
     s.  d.
     15  9
         7
  ────────
3)5  10  3
  1  16  9
```

Some accountants prove the operations of arithmetic by a method which they call casting out the 9's, depending on the following principles:

1*st*, If several numbers be divided by any divisor (the remainders being always added to the next number), the sum of the quotients, and the last remainder, will be the same as those obtained when the sum of the number is divided by the same divisor. Thus, 19, 15, and 23, contain together as many 5's, as many 7's, &c. as their sum 57 does, and the remainders are the same; and, in this way, addition may be proven by division. It is from the correspondence of the remainders that the proof by casting out the 9's is deduced.

2*dly*, If any figure with ciphers annexed be divided by 9, the quotient consists entirely of that figure; and the remainder is also the same. Thus, 40 divided by 9 quotes 4, remainder 4; and 400 divided by 9 quotes 44, remainder 4. The same holds with all the digits, and the reason will be easily understood: every digit, with a ci-

pher annexed, contains exactly so many tens; it must therefore contain an equal number of 9's, besides a remainder of an equal number of units.

3dly, If any number be divided by 9, the remainder is equal to the sum of the figures of the number, or to the remainder obtained, when that sum is divided by 9. For instance, 3765 divided by 9 leaves a remainder of 3; and the sum of 3, 7, 6, and 5, is 21, which divided by 9 leaves a remainder of 3. The reason of this will appear from the following illustration:

3000	divided by 9 quotes	333,	remainder	3
700	9 quotes	77,	remainder	7
60	9 quotes	6,	remainder	6
5	9 quotes	0,	remainder	5
3765		416,	sum of rem.	21
Again: 21	divided by 9 quotes	2,	remainder	3;
wherefore, 3765	divided by 9 quotes	418,	remainder	3;

for the reason given. Hence we may collect the following rules for practice:

To cast the 9's out of any number, or to find what remainder will be left when any number is divided by 9: add the figures; and when the sum exceeds 9, add the figures which would express it. Pass by the 9's; and when the sum comes exactly to 9, neglect it, and begin anew. For example, if it be required to cast the 9's out of 3573294, we reckon thus; 3 and 5 are 8, and 7 is 15; 1 and 5 are 6, and 3 is 9, which we neglect; 2 and (passing by 9) 4 are 6; which is the remainder or Result. If the article out of which the 9's are to be cast contains more denominations than one, we cast the 9's out of the higher, and multiply the result by the value of the lower, and carry on the product (casting out the 9's, if necessary) to the lower.

To prove addition, cast the 9's out of the several articles, carrying the results to the following articles; cast them also out of the sum. If the operation be right, the results will agree.

To prove subtraction, cast the 9's out of the minuend; cast them also out of the subtrahend and remainder together; and if you obtain the same result, the operation is presumed right.

To prove multiplication, cast the 9's out of the multiplicand, and also out of the multiplier if above 9. Multiply the results together, and cast the 9's, if necessary, out of their product. Then cast the 9's out of the product, and observe if this result correspond with the former.

Ex. 1st, 9276 res. 6 $\times$ 8 = 48 res. 3.
8
74208 res. 3.

2d, 7898 res. 5 $\times$ 3 = 15 res. 6.
48 res. 3
63184
31592
379104 res. 6.

The reason of this will be evident, if we consider multiplication under the view of repeated addition. In the first example it is obviously the same. In the second, we may suppose the multiplicand repeated 48 times. If this be done, and the 9's cast out, the result, at the end of the 9th line, will be 0; for any number, repeated 9 times, and divided by 9, leaves no remainder. The same must happen at the end of the 18th, 27th, 36th, and 45th lines; and the last result will be the same as if the multiplicand had only been repeated 3 times. This is the reason for casting out the 9's from the multiplier as well as the multiplicand.

To prove division, cast the 9's out of the divisor, and also out of the quotient; multiply the results, and cast the 9's out of the product. If there be any remainder, add to it the result, casting out the 9's if necessary. If the account be right, the last result will agree with that obtained from the dividend.

Ex. 42) 2490 (59 res. 5 $\times$ 6 = 30 res. 3.
res. 6. 210
390
378
Rem. 12 - - - res. 3.
6

And the result of the dividend is 6.

This depends on the same reason as the last; for the dividend is equal to the product of the divisor and quotient added to the remainder.

We cannot recommend this method, as it lies under the following disadvantages.

1st, If an error of 9, or any of its multiples, be committed, the results will nevertheless agree; and so the error will remain undiscovered. And this will always be the case when a figure is placed or reckoned in a wrong column, which is one of the most frequent causes of error.

2dly, When it appears by the disagreement of the results that an error has been committed, the particular figure or figures in which the error lies are not pointed out, and consequently it is not easily corrected.

Chap. VI.—Rule of Proportion.

Sect. I.—Simple Proportion.

Quantities are reckoned proportional to each other when they are connected in such a manner, that if one of them be increased or diminished, the other increases or diminishes at the same time, and the degree of the alteration on each is a like part of its original measure. Thus, four numbers are in the same proportion, the first to the second as the third to the fourth, when the first contains the second, or any part of it, as often as the third contains the fourth, or the like part of it. In either of these cases, the quotient of the first divided by the second is equal to that of the third divided by the fourth; and this quotient may be called the *measure of the proportion.*

Proportionals are marked down in the following manner:

6 : 3 :: 8 : 4
12 : 36 :: 9 : 27
9 : 6 :: 24 : 16
16 : 24 :: 10 : 15

The rule of Proportion directs us, when three numbers are given, how to find a fourth, to which the third may have the same proportion that the first has to the second. It is sometimes called the *Rule of Three,* from the three numbers given; and sometimes the *Golden Rule,* from its various and extensive utility.

Rule. *Multiply the second and third terms together, and divide the product by the first.*

Ex. To find a fourth proportional to 18, 27, and 34.

18 : 27 :: 34 : 51
34
108
81
18)918(51
90
18
18

To explain the reason of this, we must observe, that if

two or more numbers be multiplied or divided alike, the products or quotients will have the same proportion.

18 : 27
Multiplied by 34, 612 : 918
Divided by 18, 34 : 51

The products 612, 918, and the quotients 34, 51, have therefore the same proportion to each other that 18 has to 27. In the course of this operation, the products of the first and third terms are divided by the first; therefore the quotient is equal to the third.

The first and second terms must always be of the same kind; that is, either both moneys, weights, measures, both abstract numbers, or the like. The fourth, or number sought, is of the same kind as the third.

When any of the terms is in more denominations than one, we may reduce them all to the lowest. But this is not always necessary. The first and second should not be reduced lower than directed, p. 589, col. 2, par. penult.; and when either the second or third is a simple number, the other, though in different denominations, may be multiplied without reduction.

```
             £   s.  d.
Ex. 5 : 7 :: 25  11  3
                     7        £   s.  d.
    ------------------
    5)  178  18  9      (35  15   9
```

The accountant must consider the nature of every question, and observe the circumstance which the proportion depends on; and common sense will direct him to this if the terms of the question be understood. It is evident that the value, weight, and measure of any commodity is proportioned to its quantity; that the amount of work or consumption is proportioned to the time; that gain, loss, or interest, when the rate and time are fixed, is proportioned to the capital sum from which it arises; and that the effect produced by any cause is proportioned to the extent of the cause. In these and many other cases the proportion is direct, and the number sought increases or diminishes along with the term from which it is derived.

In some questions, the number sought becomes less when the circumstances from which it is derived become greater. Thus, when the price of goods increases, the quantity which may be bought for a given sum is smaller; when the number of men employed at work is increased, the time in which they may complete it becomes shorter; and when the activity of any cause is increased, the quantity necessary to produce a given effect is diminished. In these and the like the proportion is said to be inverse.

General Rule for stating all questions, whether direct or inverse. *Place that number for the third term which signifies the same kind of thing with what is sought, and consider whether the number sought will be greater or less. If greater, place the least of the other terms for the first; but if less, place the greatest for the first.*

Ex. 1*st*, If 30 horses plough 12 acres, how many will 42 plough in the same time?

```
H.  H.  A
30 :: 42 :: 12 : answer.
```

Here, because the thing sought is a number of acres, we place 12, the given number of acres, for the third term; and because 42 horses will plough more than 30, we make the lesser number, 30, the first term, and the greater number, 42, the second term.

Ex. 2*d*, If 40 horses be maintained for a certain sum on hay, at 5d. per stone, how many will be maintained on the same sum when the price of hay rises to 8d.

```
d.  d.  H.
8 : 5 :: 40 : answer.
```


Here, because a number of horses is sought, we make the given number of horses, 40, the third term: and because fewer will be maintained for the same money when the price of hay is dearer, we make the greater price, 8d. the first term, and the lesser price, 5d. the second term.

The first of these examples is direct, the second inverse. Every question consists of a supposition and demand. In the first, the supposition is, that 30 *horses plough* 12 *acres*, and the demand, *how many* 42 *will plough;* and the first term of the proportion, 30, is found in the supposition, in this and every other direct question. In the second, the supposition is, that 40 *horses are maintained on hay at* 5d., and the demand, *how many will be maintained on hay at* 8d.? and the first term of the proportion, 8, is found in the demand, in this and every other inverse question.

When a proportion is stated, if the first and second terms, or first and third, be measured by the same number, we may divide them by that measure, and use the quotients in their stead.

Ex. If 36 yards cost 42 shillings, what will 27 cost?

```
Y.   Y.   sh.        Here 36 and 27 are both
36 : 27 :: 42        measured by 9, and we work
 4 :  3 :: 42        with the quotients 4 and 3.
           3
         ----  s.  d.
   4)126(31   6, the answer.
```

SECT. II.—COMPOUND PROPORTION.

Sometimes the proportion depends upon several circumstances. Thus, it may be asked, if 18 men consume 6 bolls of corn in 28 days, how much will 24 men consume in 56 days? Here the quantity required depends partly on the number of men, partly on the time; and the question may be resolved into the two following ones:

1*st*, If 18 men consume 6 bolls in a certain time, how many will 24 men consume in the same time?

```
M.   M.  B.  B.
18 : 24 : 6 : 8        Answer, 24 men will consume 8
      6                bolls in the same time.
    ----
18) 144(8
```

2*d*, If a certain number of men consume 8 bolls in 28 days, how many will they consume in 56 days?

```
D.   D.   B.  B.
28 : 56 :: 8 : 16      Ans. The same number of men
      8                will consume 16 bolls in 56 days.
    ----
28) 448(16
```

In the course of this operation, the original number of bolls, 6, is first multiplied into 24, then divided by 18, then multiplied into 56, then divided by 28. It would answer the same purpose to collect the multipliers into one product and the divisors into another, and then to multiply the given number of bolls by the former, and divide the product by the latter, p. 590, col. 2.

The above question may therefore be stated and wrought as follows:

```
Men  18  :  24 :: 6 bolls     Here we multiply 18 into
Days 28  :  56                28 for a divisor, and 6 into
    ----   ----               the product of 24 by 56 for
     144   144                a dividend.
     36    120
    ----   ----
     504   1344
              6
           ----
     504)8064(16, answer.
```

In general, state the several particulars on which the question depends, as so many simple proportions, attending to the sense of the question to discover whether the proportions should be stated directly or inversely; then multiply all the terms in the first rank together, and all

those in the second rank together, and work with the product as directed in the simple rule (Sect. i. p. 591.)

Ex. If 100 men make 3 miles of road in 27 days, in how many days will 150 men make 5 miles?

```
Men 150 : 100 :: 27 days.
      3     5
    ---   ---
    450   500
           27
          ---
450)13500(30 days, ans.
```

Here the first stating is inverse, because more men will do it in fewer days; but the second is direct, because more miles will require more days.

The following contraction is often useful. After stating the proportion, if the same number occurs in both ranks, dash it out from both; or, if any term in the first rank and another in the second rank are measured by the same number, dash out the original terms, and use the quotients in their stead.

Ex. If 18 men consume £30 value of corn in 9 months when the price is 16s. per boll, how many will consume £54 value in 6 months when the price is 12s. per boll? In this question the proportion depends upon three particulars—the value of corn, the time, and price; the first of which is direct, because the greater the value of provisions is, the more men are required to consume them; but the second and third are inverse, for the greater the time and price are, fewer men will consume an equal value.

$$
\begin{array}{lrcrl}
\text{Value} & \cancel{30} & : & \cancel{54} & :: 18 \text{ men.} \\
\text{Months} & \cancel{6} & : & \cancel{9} & \\
\text{Price} & \cancel{12} & : & \cancel{16} & \\
 & 10 & & 9 & \\
 & \cancel{3} & & \cancel{3} & \\
 & & & 4 & \\
\hline
 & & & 36 & \\
 & & & 18 & \\
\hline
 & & & 288 & \\
 & & & 36 & \\
\hline
 & \multicolumn{4}{l}{10)648(64\tfrac{8}{10}}
\end{array}
$$

Here we observe 6 in the first rank measures 54 in the second; so we dash them out, and place the quotient 9 in the second rank. Next, because 30 and 9 are both measured by 3, we dash them out, and place down the quotients 10 and 3; then, because 12 and 16 are both measured by 4, we dash them out and place down the quotients 3 and 4. Lastly, because there is now 3 in both columns, we dash them out, and work with the remaining terms, according to the rule.

The moneys, weights, and measures of different countries may be reduced from the proportion which they bear to each other.

Ex. If 112 lb. avoirdupois make 104 lb. of Holland, and 100 lb. of Holland make 89 of Geneva, and 110 of Geneva make 117 of Seville, how many lbs. of Seville will make 100lb. avoirdupois?

```
112 : 104 :: 100
100 :  89
110 : 117
```

If it be required how many lb. avoirdupois will make 100 of Seville, then the terms must be placed in the different columns thus,—

```
104 : 112 :: 100
 89 : 100
117 : 110
```

SECT. III.—DISTRIBUTIVE PROPORTION.

If it be required to divide a number into parts which have the same proportion to each other that several other given numbers have, we add these numbers together, and state the following proportion: As the sum is to the particular numbers, so is the number required to be divided to the several parts sought.

Ex. 1. Four partners engage to trade in company; A's stock is £150, B's £320, C's £350, D's £500, and they gain £730: Required how much belongs to each if the gain be divided among them in proportion to their stocks?

					Rem.
A's stock	£150	1320 . 150 :: 730 :	£ 82	19	1—120
B's	320	1320 : 320 :: 730 :	176	19	4—960
C's	350	1320 : 350 :: 730 :	193	11	2—720
D's	500	1320 : 500 :: 730 :	276	10	3—840
Whole stock	£1320		Proof £730		

This account is proved by adding the gains of the partners, the sum of which will be equal to the whole gain if the operation be right; but if there be remainders, they must be added, their sum divided by the common divisor, and the quotient carried to the lowest place.

Ex. 2. A bankrupt owes A £146, B £170, C £45, D £480, and E £72; his whole effects are only £342. 7s. 6d. How much should each have?

A's debt	£146	913 : 146 :: £342 7 6 :	£ 54	15		A's share.
B's	170	913 : 170 :: 342 7 6 :	63	15		B's
C's	45	913 : 45 :: 342 7 6 :	16	17	6	C's
D's	480	913 : 480 :: 342 7 6 :	180			D's
E's	72	913 : 72 :: 342 7 6 :	27			E's
	£913		£342	7	6	

This might also be calculated by finding what composition the bankrupt was able to pay per pound, which is obtained by dividing the amount of his effects by the amount of his debts, and comes to 7s. 6d., and then finding by the rules of practice how much each debt came to at that rate.

CHAP. VII.—RULES FOR PRACTICE.

The operations explained in the foregoing chapters comprehend the whole system of arithmetic, and are sufficient for every computation. In many cases, however, the work may be contracted by adverting to the particular circumstances of the question. We shall explain in this chapter the most useful methods which practice has suggested for rendering mercantile computations easy, in which the four elementary rules of arithmetic are sometimes jointly, sometimes separately employed.

SECT. I.—COMPUTATION OF PRICES.

The value of any number of articles, at a pound, a shilling, or a penny, is an equal number of pounds, shillings, or pence; and these two last are easily reduced to pounds. The value at any other rate may be calculated by easy methods, depending on some contraction already explained, or on one or more of the following principles.

1*st*, If the rate be an aliquot part of a pound, a shilling, or a penny, then an exact number of articles may be bought for a pound, a shilling, or a penny; and the value is found by dividing the given number accordingly. Thus, to find the price of so many yards at 2s. 6d., which is the eighth part of a pound, we divide the quantity by eight, because every eight yards cost £1.

2*d*, If the rate be equal to the sum of two other rates which are easily calculated, the value may be found by computing these separately, and adding the sums obtained. Thus, the price of so many yards at 9d. is found by adding their prices at 6d. and 3d. together.

3*d*, If the rate be equal to the difference of two easy rates, they may be calculated separately, and the lesser subtracted from the greater. Thus, the value of so many articles at 11d. is found by subtracting their value at a penny from their value at a shilling. We may suppose that a shilling was paid for each article, and then a penny returned on each.

4*th*, If the rate be a composite number, the value may be found by calculating what it comes to at one of the component parts, and multiplying the same by the other.

CASE I. *When the rate is an aliquot part of a pound, divide the quantity by the number which may be bought for a pound.*

Table of the aliquot parts of £1.

10 shillings	$=\frac{1}{2}$ of £1.	1s. 4d.	$=\frac{1}{15}$ of £1.
6s. 8d.	$=\frac{1}{3}$	1s. 3d.	$=\frac{1}{16}$
5s.	$=\frac{1}{4}$	1s.	$=\frac{1}{20}$
4s.	$=\frac{1}{5}$	8d.	$=\frac{1}{30}$
3s. 4d.	$=\frac{1}{6}$	6d.	$=\frac{1}{40}$
2s. 6d.	$=\frac{1}{8}$	4d.	$=\frac{1}{60}$
2s.	$=\frac{1}{10}$	3d.	$=\frac{1}{80}$
1s. 8d.	$=\frac{1}{12}$	2d.	$=\frac{1}{120}$

Ex. 1*st*,] What is the value of 7463 yards, at 4s.?

5)7463
£1492. 12s.

2*d*,] What is the value of 1773 yards, at 3d.?

8|0)1773
£22. 3s. 3d.

In the first example we divide by 5 because 4s. is $\frac{1}{5}$ of a pound; the quotient 1492 shows how many pounds they amount to; besides which there remain three yards at 4s., and these come to 12s. In the second example we divide by 80, as directed, and the quotient gives £22, and the remainder 13 yards, which at 3d. come to 3s. 3d.

This method can only be used in calculating for the particular prices specified in the table. The following six cases comprehend all possible rates, and will therefore exhibit different methods of solving the foregoing questions.

Case II. *When the rate consists of shillings only, multiply the quantity by the number of shillings, and divide the product by* 20: *Or, if the number of shillings be even, multiply by half the number, and divide the product by* 10.

Ex. 1*st*,] 4573 at 13s.

13
13719
4573
20)59449
£2972. 9s.

2*d*,] 7543 at 14s.

7
10)52801
£5280. 2s.

It is easy to perceive that the method in which the second example is wrought must give the same answer as if the quantity had been multiplied by 14 and divided by 20; and as the division by 10 doubles the last figure for shillings, and continues all the rest unchanged for pounds, we may obtain the answer at once, by doubling the right-hand figure of the product before we set it down.

If the rate be the sum of two or more aliquot parts of a pound, we may calculate these as directed in Case I. and add them. If it be any odd number of shillings, we may calculate for the even number next lower, and add thereto the value of a shilling. If it be 19s. we may subtract the value at a shilling from the value at a pound.

Case III. *When the rate consists of pence only.*

Method 1. If the rate be an aliquot part of a shilling, divide the quantity accordingly, which gives the answer in shillings; if not, it may be divided into two or more aliquot parts: calculate these separately, and add the values; reduce the answer to pounds.

1 penny is $\frac{1}{12}$ of a shilling.
2d. $\frac{1}{6}$ of ditto.
3d. $\frac{1}{4}$ of ditto.
4d. $\frac{1}{3}$ of ditto.
6d. $\frac{1}{2}$ of ditto.
5d. is the sum of 4d. and 1d. or of 2d. and 3d.
7d. is the sum of 4d. and 3d. or of 6d. and 1d.
8d. is the sum of 6d. and 2d. or the double of 4d.
9d. is the sum of 6d. and 3d.
10d. is the sum of 6d. and 4d.
11d. is the sum of 6d. 3d. and 2d.

Ex. 1*st*,] 7423 at 4d.

3)7423
20)2474 4
£123 14 4

Here, because 4d. is one third of a shilling, we divide by 3, which gives the price in shillings, and reduce these by division to pounds.

Ex. 2*d*,] 9786 at 9d.

At 6d. = $\frac{1}{2}$ of 1s. 4893
At 3d. = $\frac{1}{2}$ of 6d. 2446 6
At 9d. 7339 6
£366 19 6

Here we suppose first 6d. and then 3d. to be paid for each article; half the quantity is the number of shillings they would cost at 6d. each, half of that is the cost at 3d., and these added and reduced give the answer.

Ex. 3*d*,] 4856 at 11d.

At 6d. = $\frac{1}{2}$ of 1s. 2428
At 3d. = $\frac{1}{2}$ of 6d. 1214
At 2d. = $\frac{1}{3}$ of 6d. 809 4
11d. 4451 4
£222 11 4

Here we calculate what the articles would cost at 6d., at 3d., and at 2d., and add the values.

It is sometimes easier to calculate at two rates whose difference is the rate required, and subtract the lesser value from the greater. Thus, the last example may be wrought by subtracting the value at a penny from the value at a shilling. The remainder must be the value at 11d.

At 1s. 4856s.
At 1d. = $\frac{1}{12}$ 404 8
At 11d. 4451 4
£222 11 4

10d. may be wrought as the difference of 1s. and 2d.; and several other rates in like manner.

Method 2. Multiply the quantity by the number of pence, the product is the answer in pence. Reduce it to pounds.

Method 3. Find the value at a penny by division, and multiply the same by the number of pence.

Case IV. *When the rate consists of farthings only, find the value in pence, and reduce it by division to pounds.*

Ex. 1*st*,] 37843 at 1 farthing.

4)37843 farth.
12) 9460¾ pence
788 4¾
£39 8 4¾

3*d*, 72564 at ¾

3
4)217692 farth.
12) 54423 pence
4535 3
£226 15 3

2*d*,] 23754 at ½d.

2) 23754 halfpence
12) 11877 pence
989 9
£49 9 9

Or, 72564
At ½d. 36282 d.
At ¼d. 18141 d.
12) 54423
4535 3
£226 15 3

We may also find the amount in twopences, threepences, fourpences, or sixpences, by one division, and reduce these as directed in Case I.

Case V. *When the rate consists of pence and farthings, find the value of the pence, as directed in Case III., and that of the farthings from the proportion which they bear to the pounds. Add these together, and reduce.*

Ex. 1*st*,] 3287 at 5¼d.

At 4d.=$\frac{1}{3}$ of 1s. 1095 8
At 1d.=$\frac{1}{4}$ of 4d. 273 11
At 1f.=$\frac{1}{4}$ of 1d. 68 5¾
At 5¼ 1438 0¾
£71 18 0¾

Ex. 2*d*,] 4573 at 2¾

At 2d.=$\frac{1}{6}$ of 1s. 762 2
At ½d.=$\frac{1}{4}$ of 2d. 190 6½
At ¼d.=$\frac{1}{2}$ of ½d. 95 3¼
At 2¾ 1047 11¾
£52 7 11¾

Ex. 3*d*,] 2842 at 3¾

At 3d.=$\frac{1}{4}$ of 1s. 710 6
At 3f.=$\frac{1}{4}$ of 3d. 177 7½
At 3¾ 888 1½
£44 8 1½

Ex. 4*th*,] 3572 at 7½

At 6d. =$\frac{1}{2}$ of 1s. 1786
At 1½d.=$\frac{1}{4}$ of 6d. 446 6
At 7½ 2232 6
£111 12 6

Practice.

It is sometimes best to join some of the pence with the farthings in the calculation. Thus, in Ex. 4. we reckon the value at 6d. and at 3 halfpence, which makes 7½.

If the rate be 1½, which is an eighth part of a shilling, the value is found in shillings by dividing the quantity by 8.

CASE VI. *When the rate consists of shillings and lower denominations.*

Method 1. Multiply the quantity by the shillings, and find the value of the pence and farthings, if any, from the proportion they bear to the shillings. Add and reduce.

Ex. 1*st*, 4258 at 17s. 3d.

	17
	29806
	4258
17s.	72386
3d.=¼ of 1s.	1064 6
17s. 3d.	73450 6
	£3672 10 6

Ex. 2*d*, 5482 at 12s. 4½d.

	12
12s.	65784
3d. =¼ of 1s.	1370 6
1½d.=½ of 3d.	685 3
12s. 4½d.	67839 9
	£3391 19 9

Method 2. Divide the rate into aliquot parts of a pound; calculate the values corresponding to these, as directed in Case I., and add them.

Ex. 1*st*, 3894 at 17s. 6d.

10s. =½	£1947
5s. =¼	973 10
2s. 6d.=⅛	486 15
17s. 6d.	£3407 5

Ex. 2*d*, 1765 at 9s. 2d.

6s. 8d.=⅓	£588 6 8
2s. 6d.=⅛	220 12 6
9s. 2d.	£808 19 2

Sometimes part of the value is more readily obtained from a part already found; and sometimes it is easiest to calculate at a higher rate, and subtract the value at the difference.

Ex. 3*d*, 63790 at 5s. 4d.

4s. =⅕	£12758
1s. 4d.=⅓ of 4s.	4252 13 4
5s. 4d.	£17010 13 4

Ex. 4*th*, 3664 at 14s. 9d.

10s.=½	£1832
5s.=½ of 10s.	916
15s.	2748
3d.=$\frac{1}{20}$ of 5s.	45 16
14s. 9d.	£2702 4

Method 3. If the price contain a composite number of pence, we may multiply the value at a penny by the component parts.

Ex. 5628 at 2s. 11d. or 35d.

12)5628
20)469
£23 9
5
£117 5
7
£820 15

CASE VII. *When the rate consists of pounds and lower denominations.*

Method 1. Multiply by the pounds, and find the value of the other denominations from the proportion which they bear to the pounds.

Ex. 1*st*, 3592 at £3. 12s. 8d.

	3
£3	10776
12s. =⅕ of £3	2155 4
8d.=$\frac{1}{18}$ of 12s.	119 14 8
£3 12 8	£13050 18 8

Ex. 2*d*, 543 at £2. 5s. 10½d.

	2
£2	1086
5s. =¼ of £1	135 15
10d. =⅙ of 5s.	22 12 6
½d.=$\frac{1}{20}$ of 10d.	1 2 7½
£2 5 10½	£1245 10 1½

Practice.

Method 2. Reduce the pounds to shillings, and proceed as in Case VI.

Ex. 1*st*, 3592 at £3. 12s. 8d.

	72	20
	7184	72
	25144	
	258624	
4d.=⅓s.	1197 4	
4d.=⅓s.	1197 4	
8d.	261018 8	
	£13050 18 8	

Ex. 2d, 3683. at £2. 4s. 11d.

	45
	18415
	14732
At 45s.	165735
At 1d.=$\frac{1}{12}$s.	306 11
44s. 11d.	165428 1
	£8271 8 1

We have hitherto explained the various methods of computation when the quantity is a whole number and in one denomination. It remains to give the proper directions when the quantity contains a fraction, or is expressed in several denominations.

When the quantity contains a fraction, work for the integers by the preceding rules, and for the fraction take proportional parts.

When the quantity is expressed by several denominations, and the rate given for the higher, calculate the higher, consider the lower one as fractions, and work by the last rule.

When the rate is given for the lower denomination, reduce the higher denomination to the lower, and calculate accordingly.

Note 1. 7 lb. 14 lb. and 21 lb. are aliquot parts of 1 qr.; and 16 lb is $\frac{1}{7}$ of 1 cwt.; and are therefore easily calculated.

2. If the price of a dozen be so many shillings, that of an article is as many pence; and if the price of a gross be so many shillings, that of a dozen is as many pence.

3. If the price of a ton or score be so many pounds, that of 1 cwt., or a single article, is as many shillings.

4. Though a fraction less than a farthing is of no consequence, and may be rejected, the learner must be careful lest he lose more than a farthing, by rejecting several remainders in the same calculation.

SECT. II.—DEDUCTIONS ON WEIGHTS, &c.

The full weight of any merchandise, together with that of the cask, box, or other package, in which it is contained, is called the *gross weight*. From this we must make proper deductions in order to discover the quantity for which price or duty should be charged, which is called the *nett weight*.

Tare is the allowance for the weight of the package; and this should be ascertained by weighing it before the goods are packed. Sometimes, however, particularly in payment of duty, it is customary to allow so much per cwt. or so much per 100 lb. in place of tare.

Tret is an allowance of 4 lb. on 104 granted on currants and other goods on which there is waste, in order that the weight may answer when the goods are retailed.

Cloff or Draught is a further allowance granted on some goods in London of 2 lb. on every 3 cwt. to turn the scale in favour of the purchaser. The method of calculating these, and the like, will appear from the following examples.

Commission, &c.

Ex. 1*st*, What is the nett weight of 17 cwt. 2 q. 14 lb., tare 18 lb. per cwt.

```
                     Cwt. q. lb.            Cwt. q. lb.
                     17   2  14 gross, or   17   2  14
16 lb.=1/7 cwt.       2   2   2                      6
 2 lb.=1/8 of 16 lb.      1   7 1/4         105   3  –
18 lb.                2   3   9 1/4 tare              3
                                            317   1  –
                     14   3   4 3/4 nett.28)317 1/4 lb. Cwt. q. lb.
                                         4) 11  9 1/4(2  3  9 1/4 tare.
```

In the first method we add the tare at 16 lb., which is $\frac{1}{7}$ of the gross weight, to the tare at 2 lb., which is $\frac{1}{8}$ of the former. In the second we multiply the gross weight by 18; the tare is 1 lb. for each cwt. of the product, and is reduced by division to higher denominations.

Ex. 2*d*, What is the tret of 158 cwt. 3 q. 4 lb.

```
    Cwt. q. lb.  Cwt. q. lb.
26) 158  3  4  ( 6   0  12 tret.
    156
      2
      4
     11
     28
    312
    312
```

Because tret is always 4 lb. in 104, or 1 lb. in 26, it is obtained by dividing by 26.

3*d*, What is the cloff on 28 cwt. 2 q.?

```
   Cwt. q.
    28  2
        2
3)  57  (19 lb.
```

This allowance being 2 lb. on every 3 cwt., might be found by taking $\frac{1}{3}$ of the number of cwts. and multiplying it by 2. It is better to begin with multiplication, for the reason given, p. 590, col. 2, par. 2.

SECT. III.—COMMISSION, &c.

It is frequently required to calculate allowances on sums of money, at the rate of so much per £100. Of this kind is COMMISSION, or the allowance due to a factor for buying or selling goods, or transacting any other business; PREMIUM OF INSURANCE, or allowance given for engaging to repay one's losses at sea or otherwise; EXCHANGE, or the allowance necessary to be added or subtracted for reducing the money of one place to that of another; PREMIUMS ON STOCK, or the allowance given for any share of a public stock above the original value. All these, and others of a like kind, are calculated by the following

RULE.—*Multiply the sum by the rate, and divide the product by* 100. *If the rate contain a fraction, take proportional parts.*

Ex. What is the commission on £728 at 2¾ per cent.?

```
                 728
                   2
2 per cent.     1456
   1/2           364
   1/4           182
           1|00)20|02
                  20
                  40
                  12
                 4|80
                   4  Answ. £20  0  4 3/4
                 3|20
```

When the rate is given in guineas, as once common in cases of insurance, you may add a twentieth part to the sum before you calculate; or you may calculate at an equal number of pounds, and add a twentieth part to the answer.

When the given sum is an exact number of 10 pounds, the calculation may be done without setting down any figures. Every £10 at $\frac{1}{2}$ per cent. is a shilling, and at other rates in proportion. Thus, £170 at $\frac{1}{2}$ per cent. is 17s., and at $\frac{1}{4}$ per cent. 8s. 6d.

Interest.

SECT. IV.—INTEREST.

Interest is the allowance given for the use of money by the borrower to the lender. This is computed at so many pounds for each hundred lent for a year, and a like proportion for a greater or a less time. The highest rate is limited by our laws to 5 per cent. which is called the *legal interest*, and is due on all debts constituted by bond or bill, which are not paid at the proper term; and it is always understood when no other rate is mentioned.

The interest of any sum for a year, at any rate, is found by the method explained in the last section.

The interest of any number of pounds for a year at 5 per cent. is one twentieth part, or an equal number of shillings. Thus the interest of £34675 for a year is 34675 shillings.

The interest for a day is obtained by dividing the interest for a year by the number of days in a year. Thus the interest of £34675 for a day is found by dividing 34675 shillings by 365, and comes to 95 shillings.

The interest for any number of days is obtained by multiplying the daily interest by the number of days. Thus the interest of £34675 for 17 days is 17 times 95 shillings, or 1615 shillings; and this divided by 20, in order to reduce it, comes to £80. 15s.

It would have served the same purpose, and been easier, to multiply at first by 17, the number of days; and instead of dividing separately by 365, and by 20, to divide at once by 7300, the product of 365 multiplied by 20; and this division may be facilitated by the table inserted p. 589, col. 1.

The following practical rules may be inferred from the foregoing observations.

I. To calculate interest at 5 per cent.

Multiply the principal by the number of days, and divide the product by 7300.

II. To calculate interest at any other rate.

Find what it comes to at 5 per cent. and take a proper proportion of the same for the rate required.

Ex. 1*st*, Interest on £34675 for 17 days, at 5 per cent.

```
           34675
              17
          242725
          34675         £   s.
  73|00)5894|75(80  15
          584
            5475
              20
          1095|00
            73
            365
            365
              0
```

Ex. 2*d*, Interest on £304. 3s. 4d. for 8 days, at 4 per cent.

```
           £304   3   4
                      8     s.  d.
73|00)2433   6   8(6   8
        20
      486|66
      438
       4866
         12
      584|00
      584
        0
```

Interest at 5 per cent.	£0	6	8
Deduct $\frac{1}{5}$	0	1	4
Interest at 4 per cent.	£0	5	4

Chap. VIII.—Vulgar Fractions.

In order to understand the nature of vulgar fractions, we must suppose unity (or the number 1) divided into several equal parts. One or more of these parts is called a *fraction*, and is represented by placing one number in a small character above a line, and another under it: For example, two fifth parts is written thus, $\frac{2}{5}$. The number under the line (5) shows how many parts unity is divided into, and is called the *denominator*. The number above the line (2) shows how many of these parts are represented, and is called the *numerator*.

It follows, from the manner of representing fractions, that when the numerator is increased, the value of the fraction becomes greater; but when the denominator is increased, the value becomes less. Hence we may infer, that if the numerator and denominator be both increased, or both diminished, in the same proportion, the value is not altered; and therefore, if we multiply both by any number whatever, or divide them by any number which measures both, we shall obtain other fractions of equal value. Thus, every fraction may be expressed in a variety of forms, which have all the same signification.

A fraction annexed to an integer or whole number makes a mixed number; for example, five and two third parts, or $5\frac{2}{3}$. A fraction whose numerator is greater than its denominator is called an *improper fraction;* for example, seventeen third parts, or $\frac{17}{3}$. Fractions of this kind are greater than unity. Mixed numbers may be represented in the form of improper fractions, and improper fractions may be reduced to mixed numbers, and sometimes to integers. As fractions, whether proper or improper, may be represented in different forms, we must explain the method of reducing them from one form to another before we consider the other operations.

Problem I.—To reduce mixed numbers to improper fractions.

Multiply the integer by the denominator of the fraction, and to the product add the numerator. The sum is the numerator of the improper fraction sought, and is placed above the given denominator.

Ex. $5\frac{2}{3}=\frac{17}{3}$.

```
 5 integer.
 3 denominator.
15 product.
 2 numerator given.
17 numerator sought.
```

Because one is equal to two halves, or 3 third parts, or 4 quarters, and every integer is equal to twice as many halves, or four times as many quarters, and so on, therefore, every integer may be expressed in the form of an improper fraction, having an assigned denominator. The numerator is obtained by multiplying the integer into the denominator. Hence the reason of the foregoing rule is evident: 5 reduced to an improper fraction whose denominator is 3, makes $\frac{15}{3}$, and this added to $\frac{2}{3}$ amounts to $\frac{17}{3}$.

Problem II.—To reduce improper fractions to whole or mixed numbers,

Divide the numerator by the denominator.

Ex. $\frac{112}{17}=6\frac{10}{17}$.

```
17)112(6 10/17
   102
    10
```

This problem is the converse of the former, and the reason may be illustrated in the same manner.

Problem III.—To reduce fractions to lower terms.

Divide both numerator and denominator by any number which measures both, and place the quotients in the form of a fraction.

Example. $\frac{135}{360} = \frac{27}{72} = \frac{3}{8}$.

Here we observe that 135 and 360 are both measured by 5, and the quotients form $\frac{27}{72}$, which is a fraction of the same value as $\frac{135}{360}$ in lower terms. Again, 27 and 72 are both measured by 9, and the quotients form $\frac{3}{8}$, which is still of equal value, and in lower terms.

It is generally sufficient, in practice, to divide by such measures as are found to answer on inspection, or by the rules given p. 587, col. 2. But if it be required to reduce a fraction to the lowest possible terms, we must divide the numerator and denominator by the greatest number which measures both. What number this is may not be obvious, but will always be found by the following rule.

To find the greatest common measure of two numbers, divide the greater by the lesser and the divisor by the remainder continually till nothing remains; the last divisor is the greatest common measure.

Ex. Required the greatest number which measures 475 and 589?

```
475)589(1
    475
    114)475(4
        456
         19)114(6
            114
              0
```

Here we divide 589 by 475, and the remainder is 114; then we divide 475 by 114, and the remainder is 19; then we divide 114 by 19, and there is no remainder; from which we infer that 19, the last divisor, is the greatest common measure.

To explain the reason of this, we must observe, that any number which measures two others will also measure their sum and their difference, and will measure any multiple of either. In the foregoing example, any number which measures 589 and 475 will measure their difference, 114, and will measure 456, which is a multiple of 114; and any number which measures 475 and 456 will also measure their difference, 19. Consequently, no number greater than 19 can measure 589 and 475. Again, 19 will measure them both, for it measures 114, and therefore measures 456, which is a multiple of 114 and 475, which is just 19 more than 456; and because it measures 475 and 114, it will measure their sum, 589. To reduce $\frac{475}{589}$ to the lowest possible terms, we divide both numbers by 19, and it comes to $\frac{25}{31}$.

If there be no common measure greater than 1, the fraction is already in the lowest terms.

If the greatest common measure of 3 numbers be required, we find the greatest measure of the two first, and then the greatest measure of that number and the third. If there be more numbers, we proceed in the same manner.

Problem IV.—To reduce fractions to others of equal value that have the same denominator.

1st, *Multiply the numerator of each fraction by all the deno-*

minators except its own; the products are numerators to the respective fractions sought. 2d, *Multiply all the denominators into each other; the product is the common denominator.*

Ex. $\frac{4}{5}$ and $\frac{7}{9}$ and $\frac{3}{8} = \frac{288}{360}$ and $\frac{280}{360}$ and $\frac{135}{360}$.

$4 \times 9 \times 8 = 288$ first numerator.
$7 \times 5 \times 8 = 280$ second numerator.
$3 \times 5 \times 9 = 135$ third numerator.
$5 \times 9 \times 8 = 360$ common denominator.

Here we multiply 4, the numerator of the first fraction, by 9 and 8, the denominators of the two others; and the product, 288, is the numerator of the fraction sought, equivalent to the first. The other numerators are found in like manner, and the common denominator, 360, is obtained by multiplying the given denominators 5, 9, 8, into each other. In the course of the whole operation, the numerators and denominators of each fraction are multiplied by the same number, and therefore their value is not altered.

The fractions thus obtained may be reduced to lower terms, if the several numerators and denominator have a common measure greater than unity. Or, after arranging the number for multiplication, as is done above, if the same number occur in each rank, we may dash them out and neglect them; and if numbers which have a common measure occur in each, we may dash them out and use the quotients in their stead; or any number which is a multiple of all the given denominators may be used as a common denominator. Sometimes a number of this kind will occur on inspection, and the new numerators are found by multiplying the given ones by the common denominator, and dividing the products by the respective given denominators.

If the articles given for any operation be mixed numbers, they are reduced to improper fractions by Problem I. If the answer obtained be an improper fraction, it is reduced to a mixed number by Problem II. And it is convenient to reduce fractions to lower terms, when it can be done, by Problem III. which makes their value better apprehended, and facilitates any following operation. The reduction of fractions to the same denominator by Problem IV. is necessary to prepare them for addition or subtraction, but not for multiplication or division.

SECT. I.—ADDITION OF VULGAR FRACTIONS.

RULE.—*Reduce them, if necessary, to a common denominator; add the numerators, and place the sum above the denominator.*

Ex. 1*st*, $\frac{3}{5} + \frac{2}{9} = \frac{27}{45} + \frac{10}{45}$ by Problem IV. $= \frac{37}{45}$
2*d*, $\frac{5}{7} + \frac{8}{9} + \frac{9}{10} = \frac{450}{630} + \frac{560}{630} + \frac{567}{630} = \frac{1577}{630}$
by Problem II. $= 2\frac{317}{630}$.

The numerators of fractions that have the same denominator signify like parts; and the reason for adding them is equally obvious as that for adding shillings or any other inferior denomination.

Mixed numbers may be added by annexing the sum of the fractions to the sum of the integers. If the former be a mixed number, its integer is added to the other integers.

SECT. II.—SUBTRACTION OF VULGAR FRACTIONS.

RULE.—*Reduce the fractions to a common denominator; subtract the numerator of the subtrahend from the numerator of the minuend, and place the remainder above the denominator.*

Ex. Subtract $\frac{2}{7}$ from $\frac{5}{12}$ remainder $\frac{11}{84}$

$\left.\begin{array}{l} \frac{5}{12} = \frac{35}{84} \\ \frac{2}{7} = \frac{24}{84} \end{array}\right\}$ by Prob. IV.

from 35
take 24
remainder 11.

To subtract a fraction from an integer, subtract the numerator from the denominator, and place the remainder above the denominator; prefix to this the integer diminished by unity.

Ex. Subtract $\frac{3}{5}$ from 12. remainder $11\frac{2}{5}$.

To subtract mixed numbers, proceed with the fractions by the foregoing rule, and with the integers in the common method. If the numerator of the fraction in the subtrahend exceed that in the minuend, borrow the value of the denominator, and repay it by adding 1 to the unit place of the subtrahend.

Ex. Subtract $145\frac{7}{9}$ from $248\frac{3}{5}$

$\left.\begin{array}{l} \frac{3}{5} = \frac{27}{45} \\ \frac{7}{9} = \frac{35}{45} \end{array}\right\}$ by Prob. IV.

$$\begin{array}{r} 248\frac{27}{45} \\ 145\frac{35}{45} \\ \hline 102\frac{37}{45} \end{array}$$

Here, because 27, the numerator of the fraction in the minuend, is less than 35, the numerator of the subtrahend, we borrow 45, the denominator; 27 and 45 make 72, from which we subtract 35, and obtain 37 for the numerator of the fraction in the remainder; and we repay what was borrowed, by adding 1 to 5 in the unit place of the subtrahend.

The reason of the operations in adding or subtracting fractions will be fully understood if we place the numerators of the fractions in a column like a lower denomination, and add or subtract them as integers, carrying or borrowing according to the value of the high denomination.

SECT. III.—MULTIPLICATION OF VULGAR FRACTIONS.

RULE.—*Multiply the numerators of the factors together for the numerator of the product, and the denominators together for the denominator of the product.*

Ex. 1*st*, $\frac{2}{3} \times \frac{5}{7} = \frac{10}{21}$
$2 \times 5 = 10$ num.
$3 \times 7 = 21$ den.

2*d*, $8\frac{2}{5} \times 7\frac{3}{4} = \frac{1302}{20} = 65\frac{2}{20}$
$8\frac{2}{5} = \frac{42}{5}$ by Prob. I.
$7\frac{3}{4} = \frac{31}{4}$ by ditto
$42 \times 31 = 1302$
$5 \times 4 = 20$

To multiply $\frac{5}{7}$ by $\frac{2}{3}$ is the same as to find what two third parts of $\frac{5}{7}$ comes to. If one third part only had been required, it would have been obtained by multiplying the denominator 7 by 3, because the value of fractions is lessened when their denominators are increased: and this comes to $\frac{5}{21}$; and, because two thirds were required, we must double that fraction, which is done by multiplying the numerator by 2, and comes to $\frac{10}{21}$. Hence we infer that fractions of fractions, or compound fractions, such as $\frac{2}{7}$ of $\frac{3}{5}$, are reduced to simple ones by multiplication. The same method is followed when the compound fraction is expressed in three parts or more.

The foregoing rule extends to every case when there are fractions in either factor. For mixed numbers may be reduced to improper fractions, as is done in *Ex.* 2; and integers may be written, or understood to be written, in the form of fractions whose denominator is 1. It will be convenient, however, to give some further directions for proceeding when one of the factors is an integer, or when one or both are mixed numbers.

1*st*, To multiply an integer by a fraction, multiply it by the numerator, and divide the product by the denominator.

Ex. $3756 \times \frac{3}{5} = 2253\frac{3}{5}$

$$\begin{array}{l} 3756 \\ \quad 3 \\ \hline 5)11268(2253\frac{3}{5} \end{array}$$

2*d*, To multiply an integer by a mixed number, we multiply it first by the integer and then by the fraction, and add the products.

Ex. $138 \times 5\frac{3}{4} = 793\frac{1}{2}$

$138 \times 5 = 690$
$138 \times \frac{3}{4}$

$$\begin{array}{l} 138 \\ \quad 3 \\ \hline 4)414(\quad 103\frac{1}{2} \\ \qquad\qquad\;\; \overline{793\frac{1}{2}} \end{array}$$

Vulgar Fractions.

3*d*, To multiply a mixed number by a fraction, we may multiply the integer by the fraction, and the two fractions together, and add the products.

$$
\begin{array}{lll}
\textit{Ex.}\ 15\tfrac{3}{8} \times \tfrac{2}{9} = 3\tfrac{5}{12} & & \\
15 \times \tfrac{2}{9} = 3\tfrac{3}{9} & = 3\tfrac{4}{12} & \\
\tfrac{3}{8} \times \tfrac{2}{9} = \tfrac{6}{72} & = \underline{\tfrac{1}{12}} & \\
 & \ 3\tfrac{5}{12} &
\end{array}
$$

4*th*, When both factors are mixed numbers, we may multiply each part of the multiplicand, first by the integer of the multiplier, and then by the fraction, and add the four products.

$$
\begin{array}{lll}
\textit{Ex.}\ 8\tfrac{2}{5} \text{ by } 7\tfrac{3}{4} & & \\
8 \times 7 = & 56 & \\
8 \times \tfrac{3}{4} = \tfrac{24}{4} = & 6 & \text{by Prob. II.} \\
\tfrac{2}{5} \times 7 = \tfrac{14}{5} = 2\tfrac{4}{5} & 2\tfrac{16}{20} & \\
\tfrac{2}{5} \times \tfrac{3}{4} = & \underline{\tfrac{6}{20}} & \\
\text{product} & 65\tfrac{2}{20} & \text{as before.}
\end{array}
$$

SECT. IV.—DIVISION OF VULGAR FRACTIONS.

RULE I.—*Multiply the numerator of the dividend by the denominator of the divisor. The product is the numerator of the quotient.*

II.—*Multiply the denominator of the dividend by the numerator of the divisor. The product is the denominator of the quotient.*

Ex. Divide $\frac{2}{5}$ by $\frac{7}{9}$. quotient $\frac{18}{35}$.

$2 \times 9 = 18$

$5 \times 7 = 35.$

To explain the reason of this operation, let us suppose it required to divide $\frac{2}{5}$ by 7, or to take one seventh part of that fraction. This is obtained by multiplying the denominator by 7; for the value of fractions is diminished by increasing their denominators, and comes to $\frac{2}{35}$. Again, because $\frac{7}{9}$ is nine times less than seven, the quotient of any number divided by $\frac{7}{9}$ will be nine times greater than the quotient of the same number divided by 7. Therefore we multiply $\frac{2}{35}$ by 9, and obtain $\frac{18}{35}$.

If the divisor and dividend have the same denominator, it is sufficient to divide the numerators.

Ex. $\frac{12}{17}$ divided by $\frac{3}{17}$ quotes 4.

The foregoing rule may be extended to every case by reducing integers and mixed numbers to the form of improper fractions. We shall add some directions for shortening the operation when integers and mixed numbers are concerned.

1*st*, When the dividend is an integer, multiply it by the denominator of the divisor, and divide the product by the numerator.

Ex. Divide 368 by $\frac{5}{7}$

$$
\begin{array}{l}
\ \ \underline{\ \ \ 7\ \ } \\
5)2576(515\tfrac{1}{5} \text{ quotient.}
\end{array}
$$

2*d*, When the divisor is an integer, and the dividend a fraction, multiply the denominator by the divisor, and place the product under the numerator.

Ex. Divide $\frac{3}{8}$ by 5 quotient $\frac{3}{40}$

$8 \times 5 = 40$

3*d*, When the divisor is an integer, and the dividend a mixed number, divide the integer, and annex the fraction to the remainder; then reduce the mixed number thus formed to an improper fraction, and multiply its denominator by the divisor.

Ex. To divide $576\frac{4}{11}$ by 7 quotient $82\frac{26}{77}$

$$
\begin{array}{l}
7)\ 576\ (82 \\
\ \underline{56} \\
\ \ 16 \\
\ \ \underline{14} \\
\ \ \ 2\tfrac{4}{11} = \tfrac{26}{11} \\
11 \times 7 = 77
\end{array}
$$

Here we divide 576 by 7, the quotient is 82, and the remainder 2, to which we annex the fraction $\frac{4}{11}$, and reduce $2\frac{4}{11}$ to an improper fraction $\frac{26}{11}$, and multiply its denominator by 7, which gives $\frac{26}{77}$.

Hitherto we have considered the fractions as abstract numbers, and laid down the necessary rules accordingly. We now proceed to apply these to practice. Shillings and pence may be considered as fractions of pounds, and lower denominations of any kind as fractions of higher; and any operation, where different denominations occur, may be wrought by expressing the lower ones in the form of vulgar fractions, and proceeding by the previous rules. For this purpose the two following problems are necessary.

PROBLEM V.—To reduce lower denominations to fractions of higher.

Place the given number for the numerator, and the value of the higher for the denominator.

Examples.

1. Reduce 7d. to the fraction of a shilling. Ans. $\frac{7}{12}$.
2. Reduce 7d. to a fraction of a pound. Ans. $\frac{7}{240}$.
3. Reduce 15s. 7d. to a fraction of a pound. Ans. $\frac{187}{240}$.

PROBLEM VI.—To value fractions of higher denominations.

Multiply the numerator by the value of the given denomination, and divide the product by the denominator; if there be a remainder, multiply it by the value of the next denomination, and continue the division.

Ex. 1*st*, Required the value of $\frac{17}{60}$ of L1.

$$
\begin{array}{l}
17 \\
\underline{20}\quad\ \ \textit{s.}\quad \textit{d.} \\
60)340(5\quad 8 \\
\underline{300} \\
40 \\
\underline{12} \\
60)480 \\
\underline{480}
\end{array}
$$

2*d*, Required the value of $\frac{8}{9}$ of 1 cwt.

$$
\begin{array}{l}
8 \\
\underline{4}\quad \textit{qrs.}\ \ \textit{lb.} \\
9)32(\ 3\quad 15\tfrac{5}{9} \\
\underline{27} \\
5 \\
\underline{28} \\
9)140 \\
\underline{9} \\
50 \\
\underline{45} \\
5
\end{array}
$$

In the first example we multiply the numerator 17 by 20, the number of shillings in a pound, and divide the product, 340, by 60, the denominator of the fraction, and obtain a quotient of 5 shillings; then we multiply the remainder, 40, by 12, the number of pence in a shilling, which produces 480, which, divided by 60, quotes 8d. without a remainder. In the second example we proceed in the same manner; but as there is a remainder, the quotient is completed by a fraction.

Sometimes the value of the fraction does not amount to an unit of the lowest denomination; but it may be reduced to a fraction of that or any other denomination by multiplying the numerator according to the value of the places. Thus $\frac{1}{1289}$ of a pound is equal to $\frac{12}{1289}$ of a shilling, or $\frac{240}{1289}$ of a penny, or $\frac{960}{1289}$ of a farthing.

CHAP. IX.—DECIMAL FRACTIONS.

SECT. I.—NOTATION AND REDUCTION.

Decimal fractions are such as have 10, or some power of 10 (that is 100, 1000, &c.), for a denominator: such are these,—

$\frac{3}{10}$, $\frac{24}{100}$, $\frac{75}{1000}$, $\frac{462}{100000}$;

They are more simply written thus:

·3, ·24, ·075, ·00462;

the number of figures after the point being always the same as the number of ciphers in the denominators.

In decimal fractions, as thus written, the figure next

the point, to the right, indicates so many tenths; the next so many hundredths, and so on. Thus, in the fraction ·346, the figure 3 expresses 3 tenths, 4 denotes 4 hundredths, and 6, 6 thousandths.

The use of ciphers in decimals, as well as in integers, is to bring the significant figures to their proper places, on which their value depends. As ciphers, when placed on the left hand of an integer, have no signification, but, when placed on the right hand, increase the value ten times each; so ciphers, when placed on the right hand of a decimal, have no signification, but when placed on the left hand, diminish the value ten times each.

The notation and numeration of decimals will be obvious from the following examples:

4·7 signifies four, and seven tenth parts.
·47 four tenth parts, and seven hundredth parts, or 47 hundredth parts.
·047 four hundredth parts, and seven thousandth parts, or 47 thousandth parts.
·407 four tenth parts, and seven thousandth parts, or 407 thousandth parts.
4·07 four, and seven hundredth parts.
4·007 four, and seven thousandth parts.

To reduce vulgar fractions to decimal ones. *Annex a cipher to the numerator, and divide it by the denominator, annexing a cipher continually to the remainder.*

Ex. 1*st*, $\frac{12}{75}$=·16 2*d*, $\frac{5}{64}$=·078125 3*d*, $\frac{2}{3}$=·666

```
75)120(16     64)500(078125     3)20(666
   75            448               18
   ---           ---               --
   450            520               20
   450            512               18
   ---            ---               --
                   80                20
                   64                18
                   --                --
                   160               20
                   128
                   ---
                    320
                    320
```

4*th*, $\frac{5}{6}$=·833 5*th*, $\frac{7}{27}$=·259 6*th*, $\frac{7}{22}$=·3,18,18.

```
6)50(833     27)70(259     22)70(31818
  48            54            66
  --            --            --
   20           160            40
   18           135            22
   --           ---            --
    20           250           180
    18           243           176
    --           ---           ---
    20             7            40
                                22
                                --
                                18
```

The reason of this operation will be evident, if we consider that the numerator of a vulgar fraction is understood to be divided by the denominator; and this division is actually performed when it is reduced to a decimal.

In like manner, when there is a remainder left in division, we may extend the quotient to a decimal, instead of completing it by a vulgar fraction, as in the following example:

25)646(25$\frac{21}{25}$ or 25·84.

```
     50
     --
     146
     125
     ---
Rem. 21·0
     200
     ---
      100
      100
```

From the foregoing examples we may distinguish the several kinds of decimals. Some vulgar fractions may be reduced exactly to decimals, as Ex. 1*st* and 2*d*, and are called *terminate* or *finite decimals*. Others cannot be exactly reduced, because the division always leaves a remainder; but, by continuing the division, we will perceive how the decimal may be extended to any length. These are called interminate or *infinite decimals*. If the same figure continually returns, as in Ex. 3*d* and 4*th*, they are called *repeaters*. If two or more figures return in their order, they are called *circulates*. If this regular succession go on from the beginning, they are called *pure repeaters*, or *circulates*, as Ex. 3*d* and 5*th*. If otherwise, as Ex. 4*th* and 6*th*, they are mixed *repeaters* or *circulates*, and the figures prefixed to those in regular succession are called the *finite part*. Repeating figures are generally distinguished by a dash, and circulates by a comma or other mark, at the beginning and end of the circle; and the beginning of a repeater or circulate is pointed out in the division by an asterisk.

Lower denominations may be considered as fractions of higher ones, and reduced to decimals accordingly. We may proceed by the following rule, which is the same in effect as the former.

To reduce lower denominations to decimals of higher. *Annex a cipher to the lower denomination, and divide it by the value of the higher. When there are several denominations, begin at the lowest, and reduce them in their order.*

Ex. To reduce 5 cwt. 2 qr. 21 lb. to a decimal of a ton.

```
28)210(·75     4)2·75(·6875     20)5·6875(·284375
   196            24               40
   ---            --               --
   140             35              168
   140             32              160
   ---             --              ---
                    30              87
                    28              80
                    --              --
                     20              75
                     20              60
                     --              --
                                     150
                                     140
                                     ---
                                      100
                                      100
```

Here, in order to reduce 21 lb. to a decimal of 1 qr. we annex a cipher, and divide by 28, the value of 1 qr. This gives ·75. Then we reduce 2·75 qrs. to a decimal of 1 cwt. by dividing by 4, the value of 1 cwt., and it comes to ·6875. Lastly, 5·6875 cwt. is reduced to a decimal of a ton by dividing by 20, and comes to ·284375.

To value a decimal fraction. *Multiply it by the value of the denomination, and cut off as many decimal places from the product as there are in the multiplicand. The rest are integers of the lower denomination.*

Example. What is the value of ·425 of £1?

```
     ·425
       20
  -------
sh. 8·500
        6
  -------
 d. 3·000
```

SECT. II.—ARITHMETIC OF TERMINATE DECIMALS.

The value of decimal places decreases like that of integers, ten of the lower place in either being equal to one of the next higher; and the same holds in passing from integers to decimals. Therefore, all the operations are performed in the same way with decimals, whether placed by themselves or annexed to integers, as with pure integers. The only peculiarity lies in the arrangement and pointing of the decimals.

In addition and subtraction, *Arrange units under units, tenth parts under tenth parts, and proceed as in integers.*

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32·035	from 13·348	and 12·248
116·374	take 9·2993	10·6752
160·63		
12·3645	4·0487	1·5728
321·4035		

In multiplication, *Allow as many decimal places in the product as there are in both factors. If the product has not so many places, supply them by prefixing ciphers on the left hand.*

Ex. 1*st*,	2*d*,	3*d*,
1·37	43·75	·1572
1·8	·48	·12
1096	35000	·018864
137	17500	
2·466	21·0000	

The reason of this rule may be explained, by observing, that the value of the product depends on the value of the factors; and since each decimal place in either factor diminishes its value ten times, it must equally diminish the value of the product.

To multiply decimals by 10, move the decimal point one place to the right; to multiply by 100, 1000, or the like, move it as many places to the right as there are ciphers in the multiplier.

In division, *Point the quotient so that there may be an equal number of decimal places in the dividend as in the divisor and quotient together.*

Therefore, if there be the same number of decimal places in the divisor and dividend, there will be none in the quotient.

If there be more in the dividend, the quotient will have as many as the dividend has more than the divisor.

If there be more in the divisor, we must annex (or suppose annexed) as many ciphers to the dividend as may complete the number in the divisor, and all the figures of the quotient are integers.

If the division leave a remainder, the quotient may be extended to more decimal places; but these are not regarded in fixing the decimal point.

The reason for fixing the decimal point as directed may be inferred from the rule followed in multiplication. The quotient multiplied by the divisor produces the dividend; and therefore the number of decimal places in the dividend is equal to those in the divisor and quotient together.

The first figure of the quotient is always at the same distance from the decimal point, and on the same side, as the figure of the dividend which stands above the unit place of the first product. This also takes place in integers; and the reason is the same in both.

Multiplication by fractions corresponds with division by integers, and division by fractions with multiplication by integers; when we multiply by $\frac{1}{2}$ or ·5, we obtain the same answer as when we divide by 2, and every integer has a correspondent decimal, which may be called its *reciprocal*. Multiplication by that decimal supplies the place of division by the integer, and division supplies the place of multiplication.

To find the reciprocal of any number, divide 1 with ciphers annexed by that number.

Ex. Required the reciprocal of 625.

625)1·000(·0016
625
3750
3750
0

The product of any number multiplied by ·0016 is the same as the quotient divided by 625.

Ex.	
625)9375(15	9375
625	·0016
3125	56250
3125	9375
0	15·0000

Because ·0016 is $\frac{1}{625}$ of unity, any number multiplied by that fraction will be diminished 625 times. For a like reason, the quotient of any number divided by ·0016 will be equal to the product of the same multiplied by 625.

Ex.	
·0016)516·0000(322500	516
48 · · · · ·	625
36	2580
32	1032
40	3096.
32	322500
80	
80	
0	

SECT. III.—APPROXIMATE DECIMALS.

It has been shown that some decimals, though extended to any length, are never complete; and others, which terminate at last, sometimes consist of so many places that it would be difficult in practice to extend them fully. In these cases, we may extend the decimal to three, four, or more places, according to the nature of the articles and the degree of accuracy required, and reject the rest of it as inconsiderable. In this manner we may perform any operation with ease by the common rules, and the answers we obtain are sufficiently exact for any purpose in business. Decimals thus restricted are called *approximates.*

Shillings, pence, and farthings, may be easily reduced to decimals of three places by the following rule: Take half the shillings for the first decimal place, and the number of farthings increased by one, if it amount to 24 or upwards; by two, if it amount to 48 or upwards; and by three, if it amount to 72 or upwards, for the two next places.

The reason of this is, that 20 shillings make a pound, two shillings is the tenth part of a pound, and therefore half the number of shillings makes the first decimal place. If there were 50 farthings in a shilling, or 1000 in a pound, the units of the farthings in the remainder would be thousandth parts, and the tens would be hundredth parts, and so would give the two next decimal places; but because there are only 48 farthings in a shilling, or 960 in a pound, every farthing is a little more than the thousandth part of a pound; and since 24 farthings make 25 thousandth parts, allowance is made for that excess by adding 1 for every 24 farthings, as directed.

If the number of farthings be 24, 48, or 72, and consequently the second and third decimal places 25, 50, and 75, they are exactly right; otherwise they are not quite complete, since there should be an allowance of $\frac{1}{24}$, not only for 24, 48, and 72 farthings, but for every other single farthing. They may be completed by the following rule: multiply the second and third decimal places, or their excess above 25, 50, 75, by 4. If the product amount to 24 or upwards, add 1; if 48, add 2; if 72, add 3. By this operation we obtain two decimal places more; and by continuing the same operation, we may extend the decimal till it terminate in 25, 50, 75, or in a repeater.

Decimals of sterling money of three places may easily be reduced to shillings, pence, and farthings, by the following rule: Double the first decimal place, and if the second be 5 or upwards, add 1 thereto for shillings. Then divide the second and third decimal places, or their excess above 50, by 4, first deducting 1, if it amount to 25

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or upwards; the quotient is pence, and the remainder farthings.

As this rule is the converse of the former one, the reason of the one may be inferred from that of the other. The value obtained by it, unless the decimal terminate in 25, 50, or 75, is a little more than the true value; for there should be a deduction, not only of 1 for 25, but a little deduction of $\frac{1}{25}$ on the remaining figures of these places.

We proceed to give some examples of the arithmetic of approximates, and subjoin any necessary observations.

ADDITION.

Cwt.	*qrs.*	*lb.*	
3	2	14	= 3·625
2	3	22	= 2·94642
3	3	19	= 3·91964
4	1	25	= 4·47321
14	3	24	14·96427

SUBTRACTION.

Cwt.	*qrs.*	*lb.*	
3	2	2	= 3·51785
1	1	19	= 1·41964
2	–	11	2·09821

If we value the sum of the approximates, it will fall a little short of the sum of the articles, because the decimals are not complete.

It is proper to add 1 to the last decimal place of the approximate, when the following figure would have been 5 or upwards. Thus the full decimal of 3 qrs. 22 lb. is ·946,428571, and therefore ·94643 is nearer to it than ·946,42. Approximates thus regulated will give exacter answers, sometimes above the true one and sometimes below it.

The mark + signifies that the approximate is less than the exact decimal, or requires something to be added. The mark — signifies that it is greater, or requires something to be subtracted.

MULTIPLICATION.

```
Meth. 1st, 8278+     Meth. 2d, 8278      Meth. 3d, 8278
           2153+               2153                3512
         ------              ------               -----
          24834              16556|               16556
         41390                 827|8                827
         8278                  413|90               413
        16556                   24|834               24
        -------             ---------            -----
        1782|2534           1782|2534             1782
```

Here the last four places are quite uncertain. The right-hand figure of each particular product is obtained by multiplying 8 into the figures of the multiplier; but if the multiplicand had been extended, the carriage from the right-hand place would have been taken in; consequently the right-hand place of each particular product, and the four places of the total product, which depend on these, are quite uncertain. Since part of the operation therefore is useless, we may omit it; and for this purpose it will be convenient to begin (as in p. 587, col. 1, *fifth* variety) at the highest place of the multiplier. We may perceive that all the figures on the right hand of the line in Meth. 2 serve no purpose, and may be left out if we only multiply the figures on the multiplicand, whose products are placed on the left hand of the line. This is readily done by inverting the multiplier in Meth. 3, and beginning each product with the multiplication of that figure which stands above the figure of the multiplier that produces it, and including the carriage from the right-hand place.

If both factors be approximates, there are at least as many uncertain places in the product as in the longest factor. If only one be an approximate, there are as many uncertain places as there are figures in that factor, and sometimes a place or two more, which might be affected by the carriage. Hence we may infer how far it is necessary to extend the approximates in order to obtain the requisite number of certain places in the product.

DIVISION.

```
·3724 —)798|64237 + (2144 or 3724)79864237(2144
        744|8                     7448
        ------                    ----
         53|84                     538
         37|24                     372
         -------                   ---
         16|602                    166
         14|896                    148
         -------                   ---
          1|7063                    18
          1|4896                    14
         -------                    --
           2167                      4
```

Here all the figures on the right hand of the line are uncertain, for the right-hand figure of the first product 7448 might be altered by the carriage if the divisor were extended; and all the remainders and dividuals that follow are thereby rendered uncertain. We may omit these useless figures, for which purpose we dash a figure on the right hand of the divisor at each step, and neglect it when we multiply by the figure of the quotient next obtained; but we include the carriage. The operation, and the reason of it, will appear clear, by comparing the operation at large, and contracted, in the above example.

CHAP. X.—INTERMINATE DECIMALS.

SECT. I.—REDUCTION OF INTERMINATE DECIMALS.

We have seen that some vulgar fractions admit of being converted into exact decimal fractions, while others have not that property, but proceed interminably, the numerator being either the same figure, or else a combination of figures always repeated. The fraction $\frac{3}{8}$ is of the first mentioned kind, its decimal value being $\frac{375}{1000}$, that is ·375; again, $\frac{1}{3}$=·333, &c. and $\frac{5}{7}$=·714285,714285, &c. are examples of the second kind. Let us suppose a fraction reduced to its lowest terms, $\frac{3}{8}$, for example. Now, to convert this into a decimal, we annex ciphers to the numerator (that is, we multiply it by some power of 10), and divide by the denominator, the decimal denominator being always that power of ten by which the numerator was multiplied. In the case of $\frac{3}{8}$, the numerator is multiplied by 1000, which is exactly divisible by 8; for when the numbers are expressed by the product of their simple factors, we have $1000=2\times2\times2\times5\times5\times5$ and $8=2\times2\times2$, and $\frac{1000}{8}=5\times5\times5=125$, therefore the decimal value of $\frac{3}{8}$ is $\frac{375}{1000}$, that is, ·375. Here it appears that the decimal fraction has a finite form, because the divisors of the denominator of the vulgar fraction are also divisors of a power of 10.

A like remark may be made concerning the fraction $\frac{7}{25}=\frac{7}{5\times5}$, the two equal divisors 5 being divisors of 10, and therefore their product a divisor of 100, and the fraction =·28.

In general, it appears that if the simple factors of the denominators of a vulgar fraction be all either 2 or 5, its decimal value will be finite, otherwise not.

The fraction $\frac{1}{9}$ is therefore, from its nature, incapable of being converted into a finite decimal; but this fraction, when converted into a decimal, being ·1111, &c. *ad infinitum*, therefore $\frac{2}{9}$ will be ·222, &c. and $\frac{3}{9}=\frac{1}{3}=$ ·333, &c. and so on to $\frac{8}{9}$, which will be ·888, &c. Hence it is manifest that every repeating decimal is equivalent to a vulgar fraction whose denominator is 9.

Again, since $\frac{1}{99}=$ ·010101, &c. *ad infinitum*, therefore $\frac{2}{99}=$ ·0202, &c.; and in like manner $\frac{17}{99}=$ ·1717, &c. and so on, from $\frac{1}{99}$ to $\frac{89}{99}$, which is equal to ·89,89,89, &c. Therefore every circulating decimal of two figures is convertible into a vulgar fraction whose denominator is 99.

And since $\frac{1}{999}=$ ·001001001, &c., therefore any fraction whose numerator consists of three figures, and deno-

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minator 999, must produce a circulate of three figures; for example, $\frac{365}{999}=\cdot365365365$, &c.; and in like manner, since $\frac{1}{9999}=\cdot00010001$, &c., therefore every fraction whose numerator consists of not more than four figures, and which has 9999 for a denominator, must produce a circulate of four figures, and so on.

It is now sufficiently manifest that all circulating decimals may be generated from vulgar fractions whose denominators are formed by a repetition of the figure 9; and hence it follows that every circulate may be converted into a vulgar fraction of that form.

RULES for reducing interminate decimals to vulgar fractions.

I. *If the decimal be a pure repeater, place the repeating figure for the numerator, and 9 for the denominator.*

II. *If the decimal be a pure circulate, place the circulating figures for the numerator, and as many 9's as there are places in the circle for the denominator.*

III. *If there be ciphers prefixed to the repeating or circulating figures, annex a like number to the 9's in the denominator.*

IV. *If the decimal be mixed, subtract the finite part from the whole decimal. The remainder is the numerator, and the denominator consists of as many 9's as there are places in the circle, together with as many ciphers as there are finite places before the circle.*

Thus, $\cdot235{,}62=\frac{23327}{99000}$

From the whole decimal	23562
We subtract the finite part	235
and the remainder	23327 is the numerator.

The reason may be illustrated by dividing the decimal into two parts, whereof one is finite, and the other a pure repeater or circulate, with ciphers prefixed. The sum of the vulgar fractions corresponding to these will be the value of the decimal sought.

$\cdot235{,}62$ may be divided into $\cdot235=\frac{235}{1000}$ by Rule I.
and $\cdot000{,}62=\frac{62}{99000}$ by Rules II. III.

In order to add these vulgar fractions, we reduce them to a common denominator; and for that purpose we multiply both terms of the former by 99, which gives $\frac{23265}{99000}$; then we add the numerators.

235, or, by method explained p. 586, col. 1, par. 3,

		Sum of numerators.		
99				
2115	23500	23265	or	23562
2115	235	62		235
23265	23265	23327		23327

The value of circulating decimals is not altered though one or more places be separated from the circle and considered as a finite part, providing the circle be completed. For example, $\cdot27$ may be written $\cdot2{,}72$, $\frac{270}{990}$, or $\frac{27}{99}$, which is also the value of $\cdot27$; and if two or more circles be joined, the value of the decimal is still the same. Thus, $\cdot2727=\frac{2727}{9999}$, which is reduced by dividing the terms by 101 to $\frac{27}{99}$.

All circulating decimals may be reduced to a similar form, having a like number both of finite and circulating places. For this purpose, we extend the finite part of each as far as the longest, and then extend all the circles to so many places as may be a multiple of the number of places in each.

Ex. ·34,725, extended, ·34,725725725725
·1,4562, ·14,562456245624

Here the finite part of both is extended to two places, and the circle to 12 places, which is the least multiple for circles of 3 and 4 places.

SECT. II.—ADDITION AND SUBTRACTION OF INTERMINATE DECIMALS.

To add repeating decimals. *Extend the repeating figures one place beyond the longest finite ones, and when you add the right-hand column, carry to the next by 9.*

Ex.	$\cdot3752\dot{4}$	or	$\cdot3752\dot{4}$
	$\cdot\dot{8}$		$\cdot8888\dot{8}$
	·643		·643
	$\cdot7\dot{3}$		$\cdot7333\dot{3}$
			2·64046

To subtract repeating decimals. *Extend them as directed for addition, and borrow at the right-hand place, if necessary, by 9.*

Ex. 1*st*,	$\cdot9356\dot{6}$	*Ex.* 2*d*,	·646
	$\cdot8473\dot{8}$		$\cdot5342\dot{7}$
	$\cdot0882\dot{7}$		$\cdot1117\dot{2}$

The reason of these rules will be obvious, if we recollect that repeating figures signify ninth parts. If the right-hand figure of the sum or remainder be 0, the decimal obtained is finite; otherwise it is a repeater.

To add circulating decimals. *Extend them till they become similar* (p. 603, col. 1, par. *ult.* &c.); *and when you add the right-hand column, include the figure which would have been carried if the circle had been extended farther.*

Ex. 1*st*,	*Extended.*	*Ex.* 2*d*,	*Extended.*
·574,	·574,574,	·874,	·874,874874,
·2,698,	·269,869,	$\cdot146\dot{3}$	·146,333333,
·428	·428	·1,58,	·158,585858,
·37,983	·379,839,	·32,	·323,232323,
	1·652,284,		1·503,026390,

Note 1. Repeaters mixed with circulates are extended and added as circulates.

Note 2. Sometimes it is necessary to inspect two or more columns for ascertaining the carriage; because the carriage from a lower column will sometimes raise the sum of the higher, so as to alter the carriage from it to a new circle. This occurs in Ex. 2.

Note 3. The sum of the circles must be considered as a similar circle. If it consist entirely of ciphers, the amount is terminate. If all the figures be the same, the amount is a repeater. If they can be divided into parts exactly alike, the amount is a circle of fewer places; but, for the most part, the circle of the sum is similar to the extended circles.

To subtract circulating decimals. *Extend them till they become similar; and when you subtract the right-hand figure, consider whether* 1 *would have been borrowed if the circles had been extended farther, and make allowance accordingly.*

·5,72,	·974,	or ·974974,	·8,135,		or ·8,135135,
·4,86,	·86,	·868686,	·452907,		or ·4,529074,
·0,85,		·106288,			·3,606060,
					or ·3,60

SECT. III.—MULTIPLICATION OF INTERMINATE DECIMALS.

CASE I.—*When the multiplier is finite and the multiplicand repeats, carry by* 9 *when you multiply the repeating figure; the right-hand figure of each line of the product is a repeater, and they must be extended and added accordingly.*

Ex.	$\cdot1349\dot{4}$
	·367
	$9446\dot{1}$
	$80966\dot{6}$
	$404833\dot{3}$
	$\cdot0495246\dot{1}$

If the sum of the right-hand column be an even number of 9's, the product is finite; otherwise it is a repeater.

CASE II.—*When the multiplier is finite, and the multiplicand circulates, add to each product of the right-hand figure the carriage which would have been brought to it if the circle had been extended. Each line of the product is a circle similar to the multiplicand, and therefore they must be extended and added accordingly.*

The product is commonly a circulate similar to the

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multiplicand; sometimes it circulates fewer places, repeats or becomes finite; it never circulates more places.

Ex. ·37,46, × ·235
·235
187,32,
1123,93,
7492,92,
·08804,19,

Case III.—*When the multiplier repeats or circulates, find the product as in infinite multipliers, and place under it the products which would have arisen from the repeating or circulating figures if extended.*

Ex. 1st, ·958 × ·$\dot{8}$
·8
7664|
766|4
76|64
7|664
|7664
·8515

2d, ·784 × ·36,
·36,
4704
2352
28224|
282|24
2|8224
285,09,

It is evident, that if a repeating multiplier be extended to any length, the product arising from each figure will be the same as the first, and each will stand one place to the right hand of the former. In like manner, if a circulating multiplier be extended, the product arising from each circle will be alike, and will stand as many places to the right hand of the former as there are figures in the circle. In the foregoing examples there are as many of these products repeated as is necessary for finding the total product. If we place down more, or extend them farther, it will only give a continuation of the repeaters or circulates.

The multiplication of interminate decimals may be often facilitated by reducing the multiplier to a vulgar fraction, and proceeding as directed p. 598, col. 2, par 8. Thus,

3d, ·3824 × ·$\dot{7}$ = $\frac{7}{9}$
7
9)2·6768
·2974$\dot{2}$

4th, ·384 × ·23, = $\frac{23}{90}$
23 | 2
1152 | 23
768
90)8·832
·0981$\dot{3}$.

Therefore, in order to multiply by $\dot{3}$, we take one third part of the multiplier; and, to multiply by $\dot{6}$, we take two thirds of the same. Thus,

5th, ·784 × ·$\dot{3}$ = $\frac{1}{3}$
3)·784
·261$\dot{3}$

6th, ·8761 × ·$\dot{6}$ = $\frac{2}{3}$
2
3)1·7522
·5840$\dot{6}$

As the denominator of the vulgar fractions always consists of 8's or of 9's with ciphers annexed, we may use the contraction explained p. 589, col. 1, par 1, &c.; and this will lead us exactly to the same operation which was explained above, par. 1, &c., on the principles of decimal arithmetic.

7th, ·735 × ·326 = $\frac{323}{990}$
323 | 3
2205 | 323
1470
2205
99|0)237405
2374,05
23,74
,23
·239803,

8th, ·278 × ·365, = $\frac{365}{999}$
365
1390
1668
834
999)101470,
101,
·101,571,

When the multiplier is a mixed repeater or circulate, we may proceed as in *Ex.* 4*th* and 7*th*; or we may divide the multiplier into two parts, of which the first is finite, and the second a pure repeater or circulate, with ciphers prefixed, and multiply separately by these, and add the products.

Thus, ·384 × ·2$\dot{5}$ or by ·2 = ·0768
and by ·0$\dot{5}$ = ·0213$\dot{3}$
·09813

or thus, ·384
·2$\dot{5}$
9)1920
213$\dot{3}$
768
·0981$\dot{3}$

In the following examples the multiplicand is a repeater, and therefore the multiplication by the numerator of the vulgar fraction is performed as directed above, col. 1.

9th, ·68$\dot{3}$ × $\dot{5}$ = $\frac{5}{9}$
5
9)3·41$\dot{6}$(·37,962,
27
71
63
*86
81
56
54
26
18
*86

10th, ·6$\dot{3}$ × ·2,39 = $\frac{237}{990}$
·237 | 2
443 | 237
189$\dot{9}$
1266$\dot{6}$
99)15010(·15,16,
99
511
495
*160
99
610
594
*16

In the following examples the multiplicand is a circulate, and therefore the multiplication by the numerator is performed as directed, p. 603, col. 2, par *ult.*

11*th*, ·3,81· × ·5$\dot{3}$ = $\frac{48}{90}$
48 | 5
3054 | 48
15272
9|0)183,27,(·203,63,
18
*032
27
57
54
*32

12*th*, ·12, × ·03, = $\frac{3}{99}$
3
99)36,36(·036730945821854912764,
666
723
306
936
453
576
813
216
183
846
543
486
903
126
273
756
633
396
*036

In *Ex.* 12 we have omitted the products of the divisor, and only marked down the remainders. These are found

Decimal Fractions.

by adding the left-hand figure of the dividual to the remaining figures of the same. Thus, 363 is the first dividual, and 3, the left hand figure, added to 63, the remaining figures, gives 66 for the first remainder; and the second dividual, 666, is completed by annexing the circulating figure 6, the reason of which may be explained as follows. The highest place of each dividual shows, in this example, how many hundreds it contains; and as it must contain an equal number of ninety-nines, and also an equal number of units, it follows that these units, added to the lower places, must show how far the dividual exceeds that number of ninety-nines. The figure of the quotient is generally the same as the first place of the dividual, sometimes one more. This happens in the last step of the foregoing example, and is discovered when the remainder found, as here directed, would amount to 99 or upwards; and the excess above 99 only must in that case be taken to complete the next dividual.

14*th*, ·01, × ·01, $= \frac{1}{99}$

1

99)·01(·000102030405060708091011121314151617181920
(2122232425262728293031323334353637383940
(4142434445464748495051525354555657585960
(6162636465666768697071727374757677787980
(81828384858687888990919293949596979899

The number of places in the circle of the product is sometimes very great, though there be few places in the factors; but it never exceeds the product of the denominator of the multiplier, multiplied by the number of places in the circle of the multiplicand. Therefore, if the multiplier be $\dot{3}$ or $\dot{6}$, the product may circulate three times as many places as the multiplicand; if the multiplier be any other repeater, nine times as many; if the multiplier be a circulate of two places, ninety-nine times as many: thus, in the last example, ·01, a circulate of two places, multiplied by ·01, a circulate of two places, produces a circulate of twice 99, or 198 places. And the reason of this limit may be inferred from the nature of the operation; for the greatest possible number of remainders, including 0, is equal to the divisor 99; and each remainder may afford two dividuals, if both the circulating figures, 3 and 6, occur to be annexed to it. If the multiplier circulate three places, the circle of the product, for a like reason, may extend 999 times as far as that of the multiplicand. But the number of places is often much less.

SECT. IV.—DIVISION OF INTERMINATE DECIMALS.

CASE I.—*When the dividend only is interminate, proceed as in common arithmetic; but when the figures of the dividend are exhausted, annex the repeating figure, or the circulating figures in their order, instead of ciphers, to the remainder.*

Ex. 1*st*, Divide ·5326 by ·7

·7)·532$\dot{6}$(·76,095238,
49
42
42
*066
63
36
35
16
14
26
21
56
56
*066

2*d*, Divide ·84$\dot{3}$ by 5.

5)·84$\dot{3}$(·168$\dot{6}$
5
34
30
43
40
*33
30
*33

3*d*, Divide ·6532$\dot{8}$ by 8.

8)·6532$\dot{8}$(·08166$\dot{1}$.

In these accounts the quotient is never finite. It may repeat if the dividend repeat; or, if the dividend circulate, it may circulate an equal number of places, often more, and never fewer. The greatest possible extent of the circle is found by multiplying the divisor into the number of places in the circle of the dividend. Thus, a circulate of 3 places, divided by 3, quotes a circulate of 3 times 3 or 9 places.

CASE II.—*When the divisor is interminate, the multiplications and subtractions must be performed according to the directions given for repeating and circulating decimals.*

Ex. 1*st*, Divide ·37845 by $\dot{5}$.

$\dot{5}$) ·37845(·68121
33333$\dot{3}$
4511$\dot{6}$
4444$\dot{4}$
67$\dot{2}$
55$\dot{5}$
11$\dot{6}$
111
$\dot{5}$
$\dot{5}$
0

2*d*, Divide ·245892 by 2·18

·2,18·)·245892(1·127005
218181,81,
27710,18,
21818,18,
5892,00,
4363,63,
1528,36,
1527,2$\dot{7}$,
1090,90
1090,90
0

The foregoing method is the only one which properly depends on the principles of decimal arithmetic; but it is generally shorter to proceed by the following rule.

Reduce the divisor to a vulgar fraction, multiply the dividend by the denominator, and divide the product by the numerator.

Ex. 1*st*, Divide ·37845 by $\dot{6} = \frac{5}{9}$.

9

5)3·40605(·68121.

2*d*, Divide ·3784$\dot{6}$ by $\dot{6} = \frac{2}{3}$

3

2)1·1353$\dot{6}$(·56768$\dot{3}$.

Note 1. Division by $\dot{3}$ triples the dividend, and division by $\dot{6}$ increases the dividend one half.

Note 2. When the divisor circulates, the denominator of the vulgar fraction consists of 9's, and the multiplication is sooner performed by the contraction explained p. 586, col. 1. It may be wrought in the same way when the divisor repeats, and the denominator of consequence is 9.

Note 3. If a repeating dividend be divided by a repeating or circulating divisor; or, if a circulating dividend be divided by a similar circulating divisor; or, if the number of places in the circle of the divisor be a multiple of the number in the dividend; then the product of the dividend multiplied by the denominator of the divisor will be terminate, since like figures are subtracted from like in the contracted multiplication, and consequently no remainder left.

Note 4. In other cases the original and multiplied dividend are similar, and the form of the quotient is the same as in the case of a finite divisor.

Note 5. If the terms be similar, or extended till they become so, the quotient is the same as if they were finite, and the operation may be conducted accordingly; for the quotient of vulgar fractions that have the same denominator is equal to the quotient of their numerators.

Chap. XI.—Of the Extraction of Roots.

The origin of powers of involution has already been explained under the article Algebra. There now remains, therefore, only to give the most expeditious methods of extracting the square and cube roots; the reasons of which will readily appear from what is said under that article. As for all powers above the cube, unless such as are multiples of either the square or cube, the extraction of their roots admits of no deviation from the algebraic canon, which must be always constructed on purpose for them.

If the root of any power not exceeding the seventh power be a single digit, it may be obtained by inspection from the following Table of powers.

1st power or root.	2d power or square.	3d power or cube.	4th power or biquadrate.	5th power or sursolid.	6th power or cube squared.	7th power.
1	1	1	1	1	1	1
2	4	8	16	32	64	128
3	9	27	81	243	729	2187
4	16	64	256	1024	4096	16384
5	25	125	625	3125	15625	78125
6	36	216	1296	7776	46656	279936
7	49	343	2401	16807	117649	823543
8	64	512	4096	32768	262144	2097152
9	81	729	6561	59049	531441	4782969

Sect. I.—Extraction of the Square Root.

Rule I.—*Divide the given number into periods of two figures, beginning at the right hand in integers, and pointing toward the left. But in decimals begin at the place of hundreds, and point toward the right. Every period will give one figure in the root.*

II.—*Find by the table of powers, or by trial, the nearest lesser root of the left-hand period; place the figure so found in the quot; subtract its square from the said period, and to the remainder bring down the next period for a dividual or resolvend.*

III.—*Double the quot for the first part of the divisor; inquire how often this first part is contained in the whole resolvend, excluding the unit's place; and place the figure denoting the answer both in the quot and on the right of the first part; and you have the divisor complete.*

IV.—*Multiply the divisor, thus completed, by the figure put in the quot, subtract the product from the resolvend, and to the remainder bring down the following period for a new resolvend, and then proceed as before.*

Note 1*st*, If the first part of the divisor, with unity supposed to be annexed to it, happen to be greater than the resolvend, in this case place 0 in the quot, and also on the right of the partial divisor; to the resolvend bring down another period; and proceed to divide as before.

Note 2*d*, If the product of the quotient figure into the divisor happen to be greater than the resolvend, you must go back and give a lesser figure to the quot.

Note 3*d*, If, after every period of the given number is brought down, there happen at last to be a remainder, you may continue the operation by annexing periods, or pairs of ciphers, till there be no remainder, or till the decimal part of the quot repeat or circulate, or till you think proper to limit it.

Ex. 1*st*, Required the square root of 133225.

Square number 133225(365 root.
9
1 div. 66)432 resolvend.
396 product.
2 div. 725) 3625 resolvend.
3625 product.

365
365
1825
2190
1095
133225 proof.

2*d*, Required the square root of 72, to eight decimal places.

72·00000000(8·48528137 root.
64
164)800
656
1688)14400
13504
16965)89600
84825
169702)477500
339404
169704)138096
.... 135763
2333
1697
636
509
127
118
9

After getting half of the decimal places, work by contracted division for the other half; and obtain them with the same accuracy as if the work had been at large.

3*d*, Required the square root of ·2916.

·2916(·54 root.
25
104)416
416

If the square root of a vulgar fraction be required, find the root of the given numerator for a new numerator, and find the root of the given denominator for a new denominator. Thus the square root of $\frac{4}{9}$ is $\frac{2}{3}$, and the root of $\frac{16}{25}$ is $\frac{4}{5}$; and thus the root of $\frac{25}{4}$ ($= 6\frac{1}{4}$) is $\frac{5}{2} = 2\frac{1}{2}$.

But if the root of either the numerator or denominator cannot be extracted without a remainder, reduce the vulgar fraction to a decimal, and then extract the root, as in Ex. 3*d*, above.

Sect. II.—Extraction of the Cube Root.

Rule I.—*Divide the given number into periods of three figures, beginning at the right hand in integers, and pointing toward the left. But in decimals, begin at the place of thousands, and point toward the right. The number of periods shows the number of figures in the root.*

II.—*Find by the table of powers, or by trial, the nearest lesser root of the left-hand period; place the figure so found in the quot; subtract its cube from the said period; and to the remainder bring down the next period for a dividual or resolvend.*

The divisor consists of three parts, which may be found as follows:

III. *The first part of the divisor is found thus: Multiply the square of the quot by 3, and to the product annex two ciphers; then inquire how often this first part of the divisor is contained in the resolvend, and place the figure denoting the answer in the quot.*

IV. *Multiply the former quot by 3, and the product by the figure now put in the quot; to this last product annex a cipher, and you have the second part of the divisor. Again, square the figure now put in the quot for the third part of the divisor; place these three parts under one another as in addition, and their sum will be the divisor complete.*

V. *Multiply the divisor thus completed by the figure last put in the quot, subtract the product from the resolvend, and to the remainder bring down the following period for a new resolvend, and then proceed as before.*

Note 1. If the first part of the divisor happen to be equal to or greater than the resolvend, in this case place 0 in the quot, annex two ciphers to the said first part of the divisor, to the resolvend bring down another period, and proceed to divide as before.

Note 2. If the product of the quotient figure into the divisor happen to be greater than the resolvend, you must go back, and give a lesser figure to the quot.

Note 3. If, after every period of the given number is brought down, there happen at last to be a remainder, you may continue the operation by annexing periods of three ciphers till there be no remainder, or till you have as many decimal places in the root as you judge necessary.

Ex. 1*st*, Required the cube root of 12812904.

```
Cube number 12812904(234 root.
            8
1st part 1200 }       )4812 resolvend.
2d part   180 }
3d part     9 }
1 divisor 1389 × 3=4167 product.

1st part 158700 }  )645904 resolvend.
2d part    2760 }
3d part      16 }
2 divisor 161476 × 4=645904 product.
```

Proof.

```
    234                 Square 54756
    234                           234
    936                        219024
   702                         164268
  468                          109512
Square 54756             Cube 12812904
```

Ex. 2*d*, Required the cube root of $28\frac{3}{4}$.

```
                 28·750000(3·06 root.
                 27
 270000 }        )1750000 resolvend.
   5400 }
     36 }
Divid. 275436 × 6=1652616 product.
                    97384 remainder.
```

Proof.

```
   3·06            Square 9·3636
   3·06                     3·06
   1836                   561816
  918                    280908
Square 9·3636          28·652616
                           97384 rem.
                       28·750000 cube.
```

If the cube root of a vulgar fraction be required, find the cube root of the given numerator for a new numerator, and the cube root of the given denominator for a new denominator. But if the root of either cannot be extracted without a remainder, reduce the vulgar fraction to a decimal, and then extract the root.

ARIUS, a presbyter of the church of Alexandria, celebrated as having given his name to the most extensive and formidable heresy that ever divided the Christian Church. He is supposed to have been a native of Libya, the country which gave birth in the previous century to Sabellius, the heresiarch whose doctrine represented the opposite pole to that of Arius.

It had more than once been decided by the voice of the church, in opposition to Sabellius and other heretics, that there are three distinct persons in the Divine Trinity. But the mutual relation, and the nature of the difference between these persons, had not yet formed a subject of dispute or of decision, and various opinions were held regarding it, without its being considered necessary that a distinct and precise phraseology should be adopted on a point so difficult and mysterious.

It was in the learned and disputatious city of Alexandria that the matter first came to an open controversy. Alexander, the Christian bishop of that city, maintained in an assembly of his presbyters, that the Son of God is not only equal to the Father, but of the same essence (ὁμοούσιος). Arius, who is represented as a man of great learning and eloquence, and of high reputation for sanctity and zeal, opposed his bishop, on the ground that his doctrine was a relapse into the error of Sabellius, and going to the opposite extreme, maintained that the Son was not *the same* in substance with the Father, but only *similar* (ὁμοιούσιος), and that, though the highest of all creatures, there was a time when he was not.

The opinions of Arius found many supporters, the most distinguished and influential of whom was Eusebius, bishop of Nicomedia, who, being a favourite of Constantia the sister of the emperor, secured for Arius important patronage. Alexander having failed in his attempt to extinguish the heresy by warning and remonstrance, called a council of African bishops at Alexandria (A.D. 321), which condemned the Arian doctrine as blasphemous, and cast the offender out of the church. The heresy, however, continued to spread. The Emperor Constantine, who at first treated the matter as a trifling logomachy, at length found it necessary for the peace of the church to call a general council at the city of Nicæa, in Bithynia, A.D. 325. At this celebrated assembly, composed of 318 bishops from all parts of the Christian world, the doctrine of the *consubstantiality* of the Son with the Father was, after much discussion, decreed as the orthodox faith of the church, and embodied in a definite formula, which not merely expressed the catholic faith but specially anathematized the Arian doctrine and its supporters as accursed. Arius was banished to Illyricum, his books were ordered to be burned, and capital punishment was denounced against all who should keep them in their possession.

But the heresy was not thus to be extinguished. Arius had powerful friends at court, and his party, though branded with the condemnation of the church, made continual progress. After five years' banishment he was recalled to Constantinople, where he satisfied the unsettled theological judgment of the emperor by a confession of faith so vaguely worded that, without abjuring his own opinions, he seemed

to consent to the orthodox faith. Athanasius, bishop of Alexandria, was now commanded to receive Arius and his followers into communion with the church; and indomitably resisting the imperial mandate, and the attacks of the Arian party, was, by their influence, deprived of his bishopric, and banished to Treves. A day was now fixed by the Emperor for the solemn reception of Arius into communion with the church, but on his way through the streets of Constantinople to the scene of his triumph, Arius suddenly died, in a manner which his friends regarded as the effect of poison, and his enemies as the judgment of God in answer to the prayers of their faithful bishop Alexander. It is unnecessary to say that neither theory is capable of proof. The heresy, however, did not expire with the heresiarch; his party continued still in great credit at court. Athanasius, indeed, was soon recalled from banishment, but as soon removed again; for the Arians, under the countenance of government, made and deposed bishops as it best served their purposes. In short, this heresy flourished for more than 300 years. It was the reigning religion of Spain for above two centuries: it was on the throne both in the East and West; it prevailed among the Goths, the Vandals, the Burgundians, and the Alani, and did not disappear till about the end of the eighth century. It was afterwards set on foot in the West by Servetus. Erasmus was accused of attempting to revive it in his Commentaries on the New Testament, and the great names of Grotius and Milton are claimed by its defenders. In modern times, Arianism, as a distinctive term, has been merged in that of *Unitarianism;* q.v.—See Mosheim and Neander's *Church Histories;* Burton *On the Early Heresies, &c.;* Bull's *Defence of the Nicene Faith;* and Gibbon's *History of Rome.*

ARK, Noah's, a floating vessel built by the patriarch Noah, for the preservation of his family, and the several species of animals, during the Deluge. The ark has afforded several points of curious inquiry relating to its form, capacity, materials, &c. The wood of which it was built is called in the Hebrew *gopher wood*, and in the Septuagint *square timbers.* Some translate the original *cedar*, others *pine*, others *box*, &c. Pelletier prefers cedar, on account of its incorruptibility and the great abundance of it in Asia. Fuller and Bochart contend that it was built of what the Greeks call *κυπαρισσός*, or the *cypress tree;* for, taking away the termination, *kupar* and *gopher* differ very little in sound. In what place Noah built and finished his ark is no less a matter of dispute; but the most general opinion is, that it was built in Chaldea, in the territories of Babylon. Its dimensions, as given by Moses, are 300 cubits in length, 50 in breadth, and 30 in height. Dr Arbuthnot computes its burthen at 81,062 tons. It contained, besides eight persons of Noah's family, one pair of every species of unclean animals, and seven pairs of every species of clean animals, with provisions for them all during the whole year. The insuperable difficulties connected with the belief that all the existing species of animals were provided for in the ark, are obviated by adopting the suggestion of Bishop Stillingfleet, approved by Matthew Poole, Pye Smith, Le Clerc, Rossenmüller, and others, that the Deluge did not extend beyond that region of the earth then inhabited, and that only the animals of that region were preserved in the Ark. See Deluge, and Kitto's *Biblical Cyclopædia.*

Ark of the Covenant, a kind of chest, of an oblong shape, made of shittim (acacia) wood, a cubit and a half broad and high, two cubits long, and covered on all sides with the purest gold. It was ornamented on its upper surface with a border of gold; and on each of the two sides were two gold rings, in which were placed the gold-covered poles by which it was carried. The lid or cover of the ark was made of the purest gold Over it, at the two extremities, were two cherubim, with their faces turned towards each other, and inclined a little towards the lid (or *mercy-seat*); and their wings spread out over the top of the ark.

This sacred object was deposited in the innermost part of the tabernacle, called "the holy of holies," and afterwards in the corresponding apartment of the Temple. Within it were deposited the tables of the law; beside it were preserved a golden pot full of manna, the rod of Aaron, and a copy of the book of the law.

Extreme sanctity attached to the ark, as the material symbol of the Divine presence. During the marches of the Israelites it was covered with a purple pall, and borne by the priests, with great reverence and care, in advance of the host. It is not wonderful therefore that the neighbouring idolaters looked upon it as the God of the Israelites (1 Sam. iv. 6, 7), a delusion which may have been strengthened by the figures of the cherubim on it. After the settlement of the Jews in Palestine, the ark remained in the tabernacle at Shiloh until the time of Eli, when it was carried along with the army in the war against the Philistines, under the superstitious notion that it would secure the victory to the Hebrews. Not only however were they beaten, but the ark itself was taken by the Philistines (1 Sam. iv. 3–11), whose triumph was, however, very short lived, as they were so oppressed by the hand of God, that after seven months they were glad to send it back again. After that it remained apart from the tabernacle at Kirjath-jearim, where it continued until the time of David, who succeeded in effecting its safe removal, in grand procession, to Mount Zion (2 Sam. vi.) When the Temple of Solomon was completed, the ark was deposited in the sanctuary (1 Kings viii. 6–9). What became of it when the Temple was plundered and destroyed by the Babylonians is not known. The Jews believe that it was concealed from the spoilers, and account it among the hidden things which the Messiah is to reveal. It is certain, however, from the consent of all the Jewish writers, that the old ark was not contained in the second temple, and there is no evidence that any new one was made. Indeed the absence of the ark is one of the important particulars in which this temple was held to be inferior to that of Solomon.—See Calmet's *Dissertation sur l'Arche d'Alliance.*

ARKANSAS, one of the United States of North America, lying between Lat. 33. and 36. 30. N., and Long. 89. 30. and 94. 30. W. It is bounded as follows:—North by the state of Missouri, east by the Mississippi River, south by Louisiana, west by Texas and the Indian territory. Area 52,198 square miles. Population in 1840, 97,574; and in 1850, 209,639, of whom 46,982 were slaves. The surface of Arkansas is extremely diversified, and the soil of very unequal quality, though a large proportion of it is rich and fertile. The parts bordering on the Mississippi are low, and frequently inundated: the western portion is mountainous, being traversed by the Ozarks, which attain a general altitude of 2000 feet. Its principal rivers, besides the Mississippi, are the Arkansas, the St Francis, the White River, the Ouachita or Washita, and the Red River. The climate, except in the low lands, is generally salubrious. In the north-western parts, however, the winters are severe, with much snow, and piercing north winds.

The mineral wealth of this state is greater than that of any other east of the Rocky Mountains: coal in great variety (including anthracite) and iron are most abundant; lead, zinc, manganese, gypsum, marble, and rock-salt, are plentiful; and silver and gold are found. Agriculture has hitherto been the chief pursuit of the inhabitants, who raise large quantities of cotton, maize, wheat, oats, tobacco, hemp, flax, sugar, &c. In 1850, the cotton crop amounted to 2,599,480 lb.; maize to 8,857,296 bushels; tobacco to 224,164 lb.; butter to 1,854,104 lb. The preparation of staple commodities, and various articles for home consumption, form the chief manufactures.

In 1819, Arkansas, which had previously formed a part of

the Missouri territory, became a separate territorial government; and in 1836 it was admitted into the Union as an independent state. The people have the election of the governor, who continues in office for four years; and the legislature is conducted by a senate and a house of representatives. Little Rock is the seat of government. The judiciary consists of a supreme court, with a chief-justice and two associate justices, and six circuit-courts. The judges of the supreme court are chosen by the legislature, and hold office for eight years: those of the circuit-court are elected by the people, and their term of office is limited to four years. The revenue of the state for the two years 1851 and 1852, was $162,658, the expenditure for the same period, $135,040. The public debt in October 1852 amounted to $4,151,370.

Arkansas, though possessing many natural advantages, is far behind the neighbouring states in improvement and general prosperity, and has no direct commerce, but exports its staples through New Orleans. No railways have yet been constructed in this state, though one or two lines have lately been proposed. Education is in a very backward state; the means of instruction being utterly inadequate to the requirements of the population.

Arkansas, a vast affluent of the Mississippi. It rises in the Rocky Mountains near Lat. 42. N. Long. 109. W., and after a winding course of 2170 miles, joins that river in Lat. 33. 56. N. Long. 91. 20. W., flowing generally in an eastward direction from its source as far as Long. 99., when it inclines to the south-east during the rest of its course. It flows through a well-wooded country for 100 miles from the Rocky Mountains; but in its farther progress it traverses a long tract devoid of wood, in which it expands into a wide stream, sometimes a mile in breadth, and interspersed with islands. It passes through the Ozark Mountains, and entering the state to which it gives its name, continues its course through a rich alluvial soil. It receives several considerable tributary rivers, the principal of which are the White River and the Great Canadian. Its annual inundations commence in March, and are at their height in June. It is navigable for steamboats as far as Fort Gibson, and, when in full flood, even so far as 2000 miles from its mouth.

ARKLOW, a seaport and market-town near the southern border of the county of Wicklow, 50 miles from Dublin, containing, in 1851, 3306 inhabitants. It is situated at the extremity of the beautiful Vale of Ovoca, on the acclivity of a hill extending along the right bank of the river. The town is of mean appearance, and mainly supported by the herring fishery and the export of copper pyrites from the Ovoca mines. There are oyster-beds on the coast, but the oysters are so strongly impregnated with a peculiar flavour, supposed to be derived from the mining districts, through the Ovoca River, as to be unsaleable when first taken; but after being thoroughly purged in the purer waters of the Welsh and English coast, are remarkably delicate. The coast is much exposed, and the harbour only accessible to small vessels. Arklow formerly contained a monastery and a castle, which latter was demolished by Cromwell. During the disturbances of 1798, the insurgents were defeated by the king's troops under General Needham, in a battle fought near Arklow Bridge.

ARKWRIGHT, Sir Richard, famous for his inventions in cotton spinning, was born at Preston in Lancashire, in 1732, of parents in humble circumstances. He was the youngest of thirteen children, received but a very indifferent education, and was bred to the trade of a barber. But the *res angusta domi* could not repress the native vigour of his mind, or extinguish the desire he felt to emerge from his low situation. In the year 1760 he had established himself in Bolton-le-Moor, where he exchanged the trade of a barber for that of an itinerant hair-merchant; and having discovered a valuable chemical process for dying hair, he was in consequence enabled to amass a little property. It is unfortunate that very little is known of the steps by which he was led to those inventions that raised him to distinction, and have immortalized his name. His residence in a district where a considerable manufacture of linen goods, and of linen and cotton mixed, was carried on, must have given him ample opportunities of becoming acquainted with the various processes that were in use in the cotton manufacture, and of the attempts that had been made and were then making to improve them. His attention was thus naturally drawn to this peculiar department; and, while he saw reason to conclude that it was likely to prove the most advantageous in which he could engage, he had sagacity and good fortune to invent and improve those extraordinary machines by which, unlike most inventors, he amassed vast wealth, at the same time that he added prodigiously to the demand for labour, and to the riches and comfort of the civilized world.

The *spinning-jenny*, invented in 1767 by Hargraves, a carpenter at Blackburn in Lancashire, gave the means of spinning twenty or thirty threads at once with no more labour than had previously been required to spin a single thread. The thread spun by the jenny could not, however, be used, except as weft, being destitute of the firmness or hardness required in the longitudinal threads or warp. But Mr Arkwright supplied this deficiency by the invention of the *spinning-frame*—that wonderful piece of machinery, which spins a vast number of threads of any degree of fineness and hardness, leaving to man merely to feed the machine with cotton, and to join the threads when they happen to break. It is not difficult to understand the principle on which this machine is constructed, and the mode of its operation. It consists of two pairs of rollers, turned by means of machinery. The lower roller of each pair is furrowed or fluted longitudinally, and the upper one is covered with leather, to make them take a hold of the cotton. If there were only one pair of rollers, it is clear that a carding of cotton, passed between them, would be drawn forward by the revolution of the rollers; but it would merely undergo a certain degree of compression from their action. No sooner, however, has the carding, or *roving* as it is technically termed, begun to pass through the first pair of rollers, than it is received by the second pair, which are made to revolve with (as the case may be) three, four, or five times the velocity of the first pair. By this admirable contrivance, the roving is drawn out into a thread of the desired degree of tenuity, a twist being given to it by the adaptation of the spindle and fly of the common flax wheel to the machinery.

Such is the principle on which Mr Arkwright constructed his famous spinning-frame. It is obvious that it is radically different from the previous methods of spinning either by the common hand-wheel or distaff, or by the jenny, which is only a modification of the common wheel. Spinning by rollers was an entirely original idea; and it is difficult to determine which is most worthy of admiration—the genius which led to so great a discovery, or the consummate skill and address by which it was so speedily perfected and reduced to practice. Mr Arkwright stated that he accidentally derived the first hint of his great invention from seeing a red-hot iron bar elongated by being made to pass between rollers;[1] and though

[1] See the account of Mr Arkwright, in the article Derbyshire, in the *Beauties of England and Wales*, vol. iii. p. 518. The statements in this account are of the highest authority, inasmuch as we have reason to believe it was furnished by Mr Strutt, the son of Mr Arkwright's first partner.

there is no mechanical analogy between that operation and his process of spinning, it is not difficult to imagine, that by reflecting upon it, and placing the subject in different points of view, it might lead him to his invention. The precise era of the discovery is not known; but it is most probable that the felicitous idea of spinning by rollers had occurred to his mind as early as the period when Hargraves was engaged in the invention of the jenny, or almost immediately after. Not being himself a practical mechanic, Arkwright employed a person of the name of John Kay, a watchmaker at Warrington, to whom we shall afterwards have to refer, to assist him in the preparation of the parts of his machine. Having made some progress towards the completion of his inventions, he applied in 1767 to Mr Atherton of Liverpool for pecuniary assistance to enable him to carry them into effect; but this gentleman declined embarking his property in what appeared so hazardous a speculation, though he is said to have sent him some workmen to assist in the construction of his machine; the first model of which was set up in the parlour of the house belonging to the free grammar school at Preston.

His inventions being at length brought into a pretty advanced state, Arkwright, accompanied by Kay, and a Mr Smalley of Preston, removed to Nottingham in 1768, in order to avoid the attacks of the same lawless rabble that had driven Hargraves out of Lancashire. Here his operations were at first greatly fettered by a want of capital. But Mr Strutt[1] of Derby, a gentleman of great mechanical skill, and largely engaged in the stocking manufacture, having seen Arkwright's inventions, and satisfied himself of their extraordinary value, immediately entered, conjointly with his partner Mr Need, into partnership with him. The command of the necessary funds being thus obtained, Mr Arkwright erected his first mill, which was driven by horses, at Nottingham, and took out a patent for spinning by rollers, in 1769. But as the mode of working the machinery by horse-power was found too expensive, he built a second factory, on a much larger scale, at Cromford in Derbyshire, in 1771, the machinery of which was turned by a water-wheel, after the manner of the famous silk-mill erected by Sir Thomas Lombe. Having made several additional discoveries and improvements in the processes of carding, roving, and spinning, he took out a fresh patent for the whole in 1775; and thus completed a series of machinery so various and complicated, yet so admirably combined, and well adapted to produce the intended effect, in its most perfect form, as to excite the astonishment and admiration of every one capable of appreciating the ingenuity displayed and the difficulties overcome.[2]

When the vast importance of these discoveries became known, it is not surprising that every effort should have been made to have the patents set aside, and Mr Arkwright deprived of the profit and honour to be derived from them. But after a pretty attentive consideration of the various proceedings relative to this subject, we have no hesitation in saying, that we see no good grounds for crediting the statement made in the court of king's bench in 1785, and again repeated by Mr Guest in his work on the cotton manufacture, which ascribes the invention of spinning by rollers to Highs or Hayes, from whom Arkwright is said to have learned it; and we shall now briefly state our reasons for holding this opinion.

Mr Arkwright's *first* patent for spinning by rollers, which is by far the most important, or rather, indeed, the essential part of his inventions, was obtained, as we have previously stated, in 1769; and its value and importance were no longer doubtful after the establishment of the factory at Cromford in 1771. The success which attended this novel method of spinning naturally excited the strongest desire on the part of the Lancashire manufacturers to participate in the advantages to be derived from it; and the fair presumption is, that instead of attempting clandestinely to pirate the invention, they would, had they conceived there were any good grounds to go upon, have at once contested the validity of the patent. But no such attempt was made till 1781, *twelve* years after the date of the first patent, and *six* years after the date of the second. And, even at that late period, Mr Arkwright's opponents came forward only in consequence of his having resolved to vindicate his rights, which had begun to be invaded on all sides, by raising an action against Colonel Mordaunt for an infringement of his patent. Mordaunt was supported by a combination of manufacturers; and, as they felt the question to be of the greatest importance, it is all but impossible to suppose that any thing would be omitted on their part which was conceived likely to contribute to their success. The case having been tried in the court of king's bench, after Trinity term, July 1781, the decision was unfavourable to Mr Arkwright. But it is of importance to observe, that no attempt was made at the trial to charge him with having purloined the inventions of others, and that the verdict was given on the sole ground of the *description of the machinery in the specification being obscure and indistinct.* Mr Arkwright admitted that such was partly the case; adding, however, that the obscurity charged against the specification had been intended only to prevent foreigners from pirating his inventions. On any other principle, indeed, his conduct would be inexplicable; for, as his inventions were fully known to hundreds of workmen in his own employment, and as he had sold the privilege of using them to great numbers of individuals in different parts of the country, it is impossible to suppose that he could either have expected or intended to conceal his inventions after the expiration of his patent.[3] In consequence of the result of this trial, Mr Arkwright and his partners prepared a *Case*, setting forth the value of the inventions, and the circumstances which had led to the indistinctness complained of in the specification, which they at one time intended to lay before parliament, as the foundation of an application for an act for their relief. But this intention was subsequently abandoned; and in a new trial (Arkwright *v.* Nightingale), which took place in the court of common pleas on the 17th of February 1785, Lord Loughborough, the presiding judge, having expressed himself favourably with respect to the sufficiency

[1] This was the justly celebrated Mr Jedediah Strutt. He was the son of a farmer, and was born in 1726. His father paid little attention to his education; but, under every disadvantage, he acquired an extensive knowledge of science and literature. He was the first individual who succeeded in adapting the stocking-frame to the manufacture of *ribbed* stockings. The manufacture of these stockings, which he established at Derby, was conducted on a very large scale, first by himself and his partner Mr Need, and subsequently by his sons, until about 1805, when they withdrew from this branch of business.

[2] See the *Case* of Richard Arkwright & Co. in 1782; the account of Sir Richard Arkwright in Aikin's *Biographical Dictionary*: the *History, Gazetteer, &c. of Lancashire*, by Edward Baines, vol. ii. p. 484, &c.

[3] It was erroneously stated, in an article in the *Edinburgh Review* (No. 91), from which this sketch is principally abstracted, on the authority of the article "Cotton Manufacture," in the Supplement to this work (vol. iii. p. 394), that a trial had been instituted in 1772, in which Mr Arkwright proved successful, to have the original patent set aside. But the first trial did not really take place, as above stated, till 1781.

of the specification, a verdict was given for Mr Arkwright. On this, as on the former trial, nothing was stated against the originality of the invention.

In consequence of these conflicting verdicts, the whole matter was brought, by a writ of *scire facias*, before the court of king's bench, to have the validity of the patent finally settled. And it was not till this third trial, which took place before Mr Justice Buller and a special jury, on the 25th of June 1785, that Mr Arkwright's claim to the inventions which formed the subject of the patent was disputed. To support this new allegation, Mr Arkwright's opponents brought forward, for the first time, Highs or Hayes, a reed-maker at Bolton. He stated that he had invented a machine for spinning by rollers previously to 1768; that he had employed the watchmaker Kay, to whom we have already referred, to make a model of that machine; and Kay was produced to prove that he had communicated that model to Mr Arkwright, and that that was the real source of all his pretended inventions. Having no idea that any attempt was to be made at so late a period to overturn the patent on this new ground, Mr Arkwright's counsel were not prepared with evidence to repel this statement; but it was stated by Mr Sergeant Adair, on a motion for a new trial on the 10th of November of the same year, that he was furnished with affidavits contradicting, in the most pointed manner, the evidence that had been given by Kay and others with respect to the originality of the invention. The court, however, refused to grant a new trial, on the ground, that whatever might be the fact as to the question of originality, the deficiency in the specification was enough to sustain the verdict.

But, independently altogether of the statements made on the motion for a new trial, the improbability of the story told by Highs and Kay seems glaring and obvious. Highs states in his evidence that he had accused Arkwright of getting possession of his invention by means of Kay so early as 1769, or about that period. Where, then, it may be asked, was this Mr Highs ever since that period, and particularly during the first trial in July 1781, and the second in February 1785? Living in Lancashire, associating with manufacturers, and in the habit, as he declares in his evidence, of making machines for them, he could not fail to be speedily informed with respect to the vast importance and value of the invention Mr Arkwright had purloined from him. It is impossible but he must have been acquainted with the efforts that were making by the Lancashire manufacturers to set aside the patents; and is it to be supposed, had he really been the inventor, that he would have remained for *sixteen* years a passive spectator of what was going forward? that he would have allowed Mr Arkwright to accumulate a princely fortune by means of *his* inventions, while he remained in a state of poverty? or that he would have withheld his evidence when the manufacturers attempted to wrest from Mr Arkwright what he had so unjustly appropriated? A single hint from Highs or Kay would, had their story been well founded, have sufficed to force Mr Arkwright to give them a share of his profits, or would have furnished the manufacturers with the means they were so anxious to obtain, of procuring the immediate dissolution of the patents. But it has never been alleged that Mr Arkwright took any pains to conciliate these persons: on the contrary, he treated Highs with the most perfect indifference, and not only dismissed Kay from his service, but even threatened to prosecute him on a charge of felony. And can any one imagine for a moment, that persons with so many and such overpowering temptations to speak out, and with no inducement of any sort to be silent, should have gone about for more than twice the period of a Pythagorean noviciate, with so important a secret closely pent up in their bosoms? We confess that such a supposition seems to us altogether absurd and incredible; and we believe our readers will agree with us in thinking, that it is infinitely more consistent with probability to suppose that the story of Highs and Kay had been manufactured for the occasion, than that it was really true.

The improbability of the statements made on this subject by Guest, in his *History of the Cotton Manufacture*, appear still more obvious, from his attributing to Highs the invention, not only of the spinning frame, but also of the jenny, which had been universally ascribed to Hargraves. But no weight can be attached to such rash and ill-considered statements. It would be next to a miracle, had two methods of spinning, both very ingenious, but radically different in their first principles, been invented nearly at the same time by the same individual.

It appears, from a communication from Mr Charles Wyatt to his brother, in the *Repertory of Arts* for 1817, and which has been reprinted by Mr Kennedy, in an interesting article on the Rise and Progress of the Cotton Trade, in the *Manchester Memoirs* (2d series, vol. iii. p. 135), as well as from the distinct reference to them in the *Case* printed by Mr Arkwright in 1782, that attempts had been made in the early part of last century to spin cotton by means of machinery. But these attempts proved ruinous to the parties by whom they were made; and all knowledge of the machinery by which they attempted to effect their purpose has been long since lost. Mr Kennedy says he had seen a specimen of yarn spun about 1741, by the late Mr Wyatt of Birmingham; but he expresses his opinion that no competent judge would say that it was spun by a similar machine to that of Mr Arkwright. It was not indeed alleged at any of the trials that took place with respect to the validity of his patent, nor has it ever been alleged since, that he had borrowed anything whatever from these remote attempts. If he was really indebted to them, it must have been merely for the knowledge of the fact that such attempts had been made; and this might have stimulated him to turn his attention to the subject.

We have access to know that none of Mr Arkwright's most intimate friends, and who were best acquainted with his character, ever had the slightest doubt with respect to the originality of his invention. Some of them, indeed, could speak to the circumstances from their own personal knowledge; and their testimony was uniform and consistent. Such also seems to be the opinion now generally entertained among the principal manufacturers of Manchester. In proof of this, we may again refer to Mr Kennedy's valuable paper in the *Manchester Memoirs*. Mr Kennedy is one of the most eminent and intelligent cotton manufacturers in the empire, and it is of importance to remark, that, although he was resident in Manchester in 1785, when the last trial for setting aside Mr Arkwright's patent took place, and must, therefore, have been well acquainted with all the circumstances connected with it, he does not insinuate the smallest doubt as to his being the real inventor of the spinning frame, nor even so much as once alludes to Highs.

On their first introduction, Mr Arkwright's machines were reckoned by the lower classes as even more adverse to their interests than those of Hargraves; and reiterated attacks were made on the factories built for them.[1] But

[1] Dorning Rasbotham, Esq. a magistrate near Bolton, printed, some time about the period referred to, a sensible address to the weavers and spinners, in which he endeavoured to convince them that it was for their interest to encourage inventions for abridging

how extraordinary soever it may appear, it was amongst the manufacturers that the greatest animosity existed against Mr Arkwright, and it required all the prudence for which he was so remarkable to enable him to triumph over the powerful combination that was formed against him. At the outset of the business, they unanimously refused to purchase his yarn; and when his partners, Messrs Strutt and Need, had commenced a manufacture of calicoes, the manufacturers strenuously opposed a bill to exempt calicoes from a discriminating duty of 3d a yard laid on them, over and above the ordinary duty of 3d by an old act of parliament. Luckily, however, the manufacturers failed of their object; and, in 1774, an act of parliament was obtained (14th Geo. III. cap. 72), for the encouragement of the cotton manufacture, in which fabrics made of cotton are declared to have been *lately* introduced, and are allowed to be used as "a lawful and laudable manufacture;" the duty of 6d the square yard on such cottons as are printed or stained being at the same time reduced to 3d. But this disgraceful spirit of animosity, which must, had it been successful, have proved as injurious to the interests of the manufacturers as to those of Mr Arkwright, did not content itself with actions in the courts of law, or a factious opposition to useful measures in parliament, but displayed itself in a still more striking and unjustifiable manner; for it is a fact, that a large factory, erected by Mr Arkwright at Birkacre, near Chorley, in Lancashire, was destroyed by a mob collected from the adjacent country, in the presence of a powerful body of police and military, without any one of the civil authorities requiring them to interfere to prevent so scandalous an outrage.

Fortunately, however, not for himself only, but for his country and the world, every corner of which has been benefited by his inventions, Mr Arkwright triumphed over every opposition. The same ingenuity, skill, and good sense, which had originally enabled him to invent his machine and get it introduced, enabled him to overcome the various combinations and difficulties with which he had subsequently to contend.

Though a man of great personal strength, which he is said to have displayed when young, in election riots at Preston, Mr Arkwright never enjoyed good health. During the whole of his splendid and ever memorable career of invention and discovery, he was labouring under a very severe asthmatic affection. A complication of disorders at length terminated his truly useful life in 1792, at his works at Cromford, in the sixtieth year of his age. He was high sheriff of Derbyshire in 1786; and, having presented a congratulatory address from the wapentake of Wirksworth to his majesty George III., on his escape from the attempt on his life by Margaret Nicholson, received the honour of knighthood. No man ever better deserved his good fortune, or has a stronger claim on the respect and gratitude of posterity. His inventions have opened a new and boundless field of employment; and while they have conferred infinitely more real benefit on his native country than she could have derived from the absolute dominion of Mexico and Peru, they have been *universally* productive of wealth and enjoyments.

"The originality and comprehensiveness of Sir Richard Arkwright's mind," says Mr Bannatyne, "was perhaps marked by nothing more strongly than the judgment with which, although new to business, he conducted the great concerns his discovery gave rise to, and the systematic order and arrangement which he introduced into every department of his extensive works. His plans of management, which must have been entirely his own, as no establishment of a similar nature then existed, were universally adopted by others; and, after long experience, they have not yet, in any material point been altered or improved." (J. R. M.)

ARLAND, Jacques Antoine, a celebrated miniature painter, born at Geneva in 1668. He came to England in 1721, where he made a considerable fortune, and had a great reputation. He returned to his native country, and died there in 1743.

ARLES, an arrondissement in the department of the Mouths of the Rhone, in France, extending over 900 square miles, or 576,124 acres. It is divided into eight cantons, and subdivided into thirty-one communes, which in 1851 contained 87,749 inhabitants.

Arles (the ancient *Arelas*, or *Arelate*), a city of France, in the department of Bouches du Rhone, and capital of an arrondissement of its own name, 46 miles north-west of Marseilles, with which, and with Avignon, it is connected by railway. Lat. 43. 40. 18. N. Long. 4. 37. 46. E. It stands on the left bank of the Rhone, where that river divides to form its Delta; and to obviate the inconvenience of the difficult navigation, the *Canal d'Arles* has been constructed, extending to the harbour of Bouc on the Mediterranean, a distance of 25 miles. It is also connected with the canal of Beaucaire, and by that of Craponne with the Durance. The town is inclosed with old walls; the streets are narrow, dirty, and intricate; and the houses generally are old and mean. The marshes in the vicinity render it somewhat unhealthy. It has a handsome town-hall, an ancient cathedral, a college, school of navigation, museum, public library, docks for ship-building, &c. The principal manufactures are silk, soap, glass bottles; and its sausages are famous. The trade also in agricultural produce, cattle, wool, and salt, is considerable. Pop. in 1846, 14,239.

Arles possesses many magnificent and interesting monuments of its ancient grandeur. The remains of its amphitheatre, which was capable of containing from 25,000 to 30,000 spectators, measure 459 feet in length by 338 feet in width. It has also remains of a Roman theatre, in which the celebrated statue known as the "Venus of Arles" was discovered in 1651; the ruins of two temples, an aqueduct, a triumphal arch, and an extensive cemetery containing many sarcophagi, the *Elysii campi* of the Romans, whence its modern appellation of *Aliscamps*. In front of the town-hall, and in the centre of the *Place Royale*, is a plain granite obelisk of a single block 47 feet long, erected on a pedestal 20 feet in height. This obelisk, which had long lain buried in the earth, was elevated to its present position in 1676. It was once supposed to be Egyptian, but it is now ascertained to have been brought from a quarry in the Estrelle Mountains near Frejus; besides, it tapers more rapidly than those of Egypt, and has no hieroglyphics. Arelate was an important town when Cæsar invaded Gaul. Subsequently, a Roman colony was established there; and in the time of the Emperors it became one of the most flourishing towns on this side of the Alps. After being pillaged A.D. 270, it was repaired, embellished, and greatly enlarged by Constantine; and here his son Constantine II. was born. On

labour. The result has shown the soundness of Mr Rasbotham's opinion. It is doubtful whether 30,000 persons were employed in all the branches of the cotton manufacture in 1767; whereas, in consequence of those very inventions which the workmen endeavoured to destroy, there are now upwards of 1,000,000 directly engaged in its different departments! There is, in fact, no idea so groundless and absurd as that which supposes that an increased facility of production can, under any circumstances, be injurious to the labourers.

the fall of the Roman empire, Arelate came into the power of the Visigoths, and rapidly declined; and in 730 it was plundered by the Saracens. In 933 it became the capital of a kingdom of the same name, formed by the union of the two kingdoms of Burgundy (Cisjurian and Transjurian). In the twelfth century it formed a republic; and in 1251 it submitted to Charles of Anjou, Count of Provence, and was united to the crown with that province in the reign of Louis XI. Many ecclesiastical councils have been held here; the most important of which was that against the Donatists in 314.

ARMADA, a Spanish term, signifying a fleet of men of war. The armada which attempted to invade England in the time of Queen Elizabeth is famous in history. See England

ARMADILLO, in *Zoology*. See Mammalia, *Index*.

ARMAGEDDON, properly "the Mountain of Megiddo," a city on the west of the river Jordan, rebuilt by Solomon (1 Kings ix. 15). Both Ahaziah and Josias died there. The same spot witnessed, at an earlier period, the greatest triumph of Israel, when "fought the kings of Canaan in Taanach by the waters of Megiddo" (Judg. v. 19). "He gathered them together into a place called in the Hebrew tongue Armageddon," is the language of the Apocalypse; a passage which has given rise to much ingenious speculation.

ARMAGH, an inland county, in the province of Ulster, in Ireland, situate between Lat. 54. 3. and 54. 31. N., and Long. 6. 14. and 6. 45. W.; comprising, according to the ordnance survey, an area of 512½ square miles, or 328,076 acres, of which 265,243 are arable, 35,117 uncultivated, 8996 in plantations, 778 in towns, and 17,942, including a portion of Lough Neagh, under water. It is bounded on the north by Lough Neagh, on the east by the county of Down, on the the south by Louth, and on the west by Monaghan and Tyrone.

The county was made shire ground in 1586, and called Armagh after the city of the same name, by the Lord Deputy, Sir John Perrott, who projected the division of the greater part of the province of Ulster into seven counties. When James I. proceeded to plant with English and Scotch colonists, the vast tracts of land escheated to the crown in Ulster, the whole of the arable and pasture land in Armagh, estimated at 77,800 acres, was to have been allotted in 61 portions, 19 of which, comprising 22,180 acres were to have been allotted to the church, and 42, amounting to 55,620 acres, to English and Scotch colonists, servitors, native Irish, and four corporate towns,—the swordsmen to be dispersed throughout Connaught and Munster. This project was not strictly adhered to in the county of Armagh, neither were the Irish swordsmen or soldiers transplanted into Connaught and Munster from this or some other counties.

Armagh is now divided into eight baronies, viz., Armagh, Fews Lower and Upper, Oneiland East and West, Orior Lower and Upper, and Turenny. It contains 28 parishes and parts of parishes, the greater number of which are in the archdiocese of Armagh, and a few in the diocese of Dromore. The county is in the Belfast military district, having barracks at Armagh, Charlemont, and Newry, and the headquarters of the county militia are at Markethill. The constabulary force consists of 278 men and officers, with headquarters at Armagh, and five districts, comprising 36 stations, at Armagh, Ballybot, Crossmaglen, Newtown-Hamilton, and Portadown. Assizes are held at Armagh, where the county prison, the county infirmary, and the district lunatic asylum are situated. The only savings bank in the county is at Armagh. There are two poor-law unions, Armagh (partly in Tyrone) and Lurgan (partly in Antrim and Down). The amount of property in the county, valued under the act 6th and 7th Will. IV., cap. 84 (Griffith's Valuation), is L.236,860, and the net annual value of property rated to the poor is L.310,061. The chief towns are the city and borough of Armagh, population in 1851, 9306; Lurgan, 4211; Portadown, 3091; the smaller market-towns of Tanderagee, Markethill, and Newtown-Hamilton, part of Newry also, with 3875 inhabitants, is in this county, the remainder, with 9616 inhabitants, being in the county of Down. The county returns three members to the Imperial Parliament, two for the county at large,—constituency in 1851, under 13th and 14th Vict., cap. 69, 4321; and one for Armagh city,—constituency 318.

Armagh is supposed to have formed part of the district described by Ptolemy as the possessions of the Vinderii and Voluntii; and afterwards, together with Louth, Monaghan, and some smaller districts, formed part of a territory called Orgial or Urial. For about two centuries it was subject to the occasional incursions of the Danes. The antiquities of the county consist of cairns and tumuli, the remains of the fortress of Eamania near Armagh, once the residence of the kings of Ulster; the Dane's Cast, an extensive fortification in the south-eastern portion of the county, extending into the county of Down; spears, battle-axes, collars, rings, amulets, medals of gold, ornaments of silver, jet, and amber, &c., have also been found in various places. The religious houses were at Armagh, Clonfeacle, Killevy, Kilmore, Stradhailloyse, and Tahenny. Of military antiquities the most remarkable are Tyrone's ditches, near Poyntz-Pass, Castle Roe, the fort of Navan, the castles of Criff-Keirn and Argonell, and that in the pass of Moyrath.

The general surface of the county is gently undulating and pleasingly diversified; but in the northern extremity, on the borders of Lough Neagh, is a considerable tract of low marshy land, and the southern border of the county is occupied by a barren range of hills, the highest of which, named Slieve Gullion, attains an elevation of 1893 feet, being the highest mountain in Ulster excepting Slieve Donard in the county of Down. The summit of Slieve Gullion, commanding one of the finest prospects in the province, is crowned by a large cairn or pile of stones which forms the roof of a singular cavern of artificial construction. In the western portion of the county are the Few Mountains, a chain of abrupt hills mostly incapable of cultivation.

The soil of the northern portion of the county is a rich brown loam, on a substratum of clay or gravel, with an abundance of limestone near Armagh and other places. Towards Charlemont there is much reclaimable bog resting on a limestone substratum. The eastern portion of the county is generally of a light friable soil; the southern portion rocky and barren, with but little bog except in the neighbourhood of Newtown-Hamilton. The climate of Armagh is considered to be one of the most genial in Ireland, and less rain is supposed to fall in this than in any other county.

The county is well watered by numerous streams; the principal are the Callen, the Tynan, and the Tallwater, flowing into the Blackwater, which after forming part of the boundary between this county and Tyrone, empties itself into the south-western angle of Lough Neagh. The Tara, the Newtown-Hamilton, the Creggan, and the Fleury, flow into the Bay of Dundalk. The Cam or Camlin joins the Bann, which, rising in the Mourne Mountains, in the southern extremity of the county of Down, forms part of the western boundary of Armagh county, and falls into Loch Neagh to the east of the Blackwater. The Newry canal, communicating with Carlingford Lough at Warrenspoint, six miles below Newry, proceeds northwards through the county of Armagh for about 21 miles, joining the Bann at Whitecoat, in the bed of which river it is continued to Lough Neagh. The tolls, arising from tonnage dues of one shilling per ton inwards and one penny per ton outwards, amount to about L.5000 per annum. The Ulster Canal commences at Charlemont on the River Blackwater, near its junction with Lough Neagh, proceeding through the western border of the county and passing thence to the south-west by Monaghan and Clones into Upper Lough Erne, after a course of 48 miles.

The geological features of the county are various and interesting. The granite of Slieve Gullion, an offset of the granite district of Down, is often used for millstones, being very hard and fine grained. The Newry Mountains and the Fathom Hills are also composed of granite. Around Camlough large beds of mica-slate exist. Slate quarries have been worked partially at Dorcy, Newtown-Hamilton, Creggan Duff, and in the neighbourhood of Crossmaglen. Lead mines have been worked, but

hitherto without much success, near Keady and at Derrynoose near Middleton; there are also indications of lead at Drumnahoney near Markethill, and at Ballymore near Poyntz-Pass; of copper at Killevy near Newry, and of manganese and antimony in the neighbourhood of Keady. The other mineral substances found are potters' clay and a variety of ochres. A very peculiar deposit of fuel more recent than coal, viz., the lignite or wood-coal of Lough Neagh is found in the district included between Washing Bay in Tyrone and Sandy Bay in Antrim; it is so abundant in some places that pits have been sunk to raise it when other fuel was scarce. Sir Robert Kane states in his work on the *Industrial Resources of Ireland*, that the economic value of the lignite appears by analysis to be about two-thirds that of average coal, and in all respects as to application to industrial uses the position of lignite is between that of coal and wood. The heat produced from it is more diffused but less intense than that from coal. There are many mineral springs scattered throughout the county, generally deriving their virtues from carbonate of iron, but none have hitherto been employed medicinally.

The total population in 1821 amounted to 197,427 souls, being at the rate of one individual to every acre and a-half, or one family to every eight acres. Of this population, 28,905 were described as being employed in agriculture, 67,182 in trade, manufactures, and commerce, and 14,521 in other occupations, leaving 86,819 of both sexes and of every age unoccupied. In 1831 and 1841 the population was 220,134 and 232,393 respectively, but in 1851 the numbers had declined to 196,085, inhabiting 35,073 houses. Armagh, however, still remains, in proportion to its area, the most densely peopled county in Ireland, excepting that of Dublin, which includes the metropolis.

The land is in general but indifferently cultivated, yet owing to the occupation of the peasantry in various branches of the linen manufacture they are better lodged, clothed, and fed than in most other parts of Ireland. The cultivation of grain is somewhat on the decrease; that of green crops, on the contrary, increases, and the number of acres under flax had increased from 5181 in 1849 to 13,052 in 1851. The total amount of land under crops amounted in 1851 to 175,662, viz., wheat, 16,320; oats, 77,347; barley, bere, and rye, 3314; beans and pease, 1168; potatoes, 31,887; turnips 7870; other green crops, 3071; flax, 13,032; meadow and clover, 21,632.

In consequence of the dense population the farms are in general very small, and show less tendency to decrease in number than those of most other parts of Ireland. Notwithstanding the very diminutive size of the farms, their owners are generally in circumstances of comparative comfort, owing to their employment in the linen manufacture. There are few who do not keep at least one cow, or a few sheep; none but the poorest cottar is without a pig. Their usual diet is oatmeal, potatoes, and milk porridge, varied sometimes by salt herrings. The better description of farmers use animal food, chiefly bacon and poultry.

The principal manufacture, and that which has given a peculiar tone to the character of the population is the linen. It is noways necessary to the promotion of this manufacture that the spinners and weavers should be congregated in large towns, or united in crowded and unwholesome factories. On the contrary, most of its branches can be carried on in the cottages of the peasantry. The men devote to the loom those hours which are not required for the cultivation of their little farms; the women spin and reel the yarn during the intervals of their other domestic occupations. Smooth lawns, perennial streams, pure springs, and the open face of heaven, are necessary for perfecting the bleaching process. Hence the extensive bleachers, with all their assistants and machinery, dwell in the country. Such is the effect of this combination of agricultural occupations with domestic manufactures, that the farmers are more than competent to supply the resident population of the county with vegetable, though not with animal, food; and some of the less crowded and less productive parts of Ulster receive from it a considerable supply of oats, barley, and flour. Apples are grown in such quantities as to entitle the county to the epithet bestowed on it, of the orchard of Ireland.

Armagh.

In the towns and level parts of the county the Protestant religion, in its two principal forms of the Established Episcopal and Presbyterian church, predominates; but the Roman Catholic is prevalent in the mountainous and less cultivated parts. As far as may be conjectured from the returns of the commissioners of education, the Roman Catholics constitute nearly one half of the gross population.

According to those returns, the number of children at school in 1824 amounted to 13,800. If the total number of children between five and fifteen years of age, which may be called the period of education, were 49,000, as stated in the population returns of 1821, upwards of two-thirds of the whole remained uninstructed. In 1851, there were 111 national schools in operation, attended by 9458 children; 5500 males and 3958 females.

The union of manufacturing and agricultural industry in contributing to their prosperity, has also had a strikingly favourable effect on the manners and appearance of the people. (H. S—R.)

Armagh, a city and parliamentary borough, in the county of the same name, 82 miles north of Dublin, in Lat. 54. 20. 55. N. and in Long. 6. 37. 57. W. It is delightfully situated on the side of a steep hill, almost in the centre of a fertile valley. With the exception of Kilkenny and Clonmel, Armagh is the most populous inland town in Ireland. It is the seat of the archiepiscopal see of the primate of all Ireland, whose ecclesiastical province comprises six consolidated dioceses. 1. Armagh and Clogher; 2. Tuam, Ardagh, Killala, and Achonry; 3. Derry and Raphoe; 4. Down, Connor, and Dromore; 5. Kilmore and Elphin; 6. Meath. The corporation which was styled "the Sovereign, Free Burgesses, and Commonalty of the Borough of Armagh," was abolished by the provisions of the Municipal Reform Bill. Markets are held on Tuesdays for general purposes, and on Wednesdays and Saturdays for grain. The city is connected with Belfast by the Ulster Railway, and will on the completion of the Newry and Enniskillen railway, possess direct communication with those towns. The borough of Armagh (constituency in 1851, 318) returns one member to the Imperial parliament. Pop. in 1851, 9306.

Armagh, though now much reduced in population, was once considered as the metropolis of the island, and second only to Dublin in the number of its inhabitants. The honour of being its founder is attributed to St Patrick. It was built on an eminence named Druimsailech, or the Hill of Willows; its present name is supposed to be a slight corruption of Ardmacha, the High Place or Field. In 448 a synod was held here, the canons of which are still in existence. During the period anterior to the arrival of the English in Ireland, it suffered extremely from the assaults of the Danes, by whom it was repeatedly plundered and burnt. Nor was its condition much bettered by the change of masters. De Courcy, FitzAdelm, and De Lacy, pillaged it in turn in their attempts to subdue Ulster; and it was exposed to similar calamities during the wars by which the north of Ireland was desolated in the reign of Elizabeth. Her successor, James I., granted it a charter, according to which it has since been governed. Its decline was accelerated by the non-residence of the archbishops, who, in consequence of the unsettled state of the northern province, fixed their residence for many years at Drogheda. From this deplorable state it was raised by Lord Rokeby, better known by the name of Primate Robinson. When he determined to make it the seat of his permanent residence, this venerable city was little more than a collection of cabins. He erected in it an archiepiscopal palace, a college or grammar school for classical education, a public library, now containing about 14,000 volumes, and an observatory well furnished with astronomical instruments. Besides these, the city now contains a Roman Catholic

chapel, a Roman Catholic cathedral in course of erection, three Presbyterian churches, and several places of worship for other religious denominations. Its other public buildings are, the cathedral, a cruciform building, repaired and beautified chiefly at the expense of the present primate, more remarkable for its antiquity than its architectural beauty, the court-house, the prison, the charter-school, the barrack, the county infirmary, the lunatic asylum, and the fever hospital, which last was erected and is maintained at the expense of Lord John George Beresford, the present primate. (H. S—R.)

ARMAGNAC, a small territory of France, in the old province of Gascony, now forming a part of the departments of Gers, Haut Pyrenees, and Tarn and Garonne. It gave a title to the descendants of the ancient dukes of Gascony and Aquitaine. The counts of Armagnac bore a conspicuous part in the wars of France and England in the fifteenth century. See FRANCE.

ARMATURA, in a general sense, is synonymous with *armour*. It is more particularly used in the Roman military art to denote a kind of exercise performed with missile weapons. In this sense armatura stands contradistinguished from palaria; the latter being the exercise of the heavy-armed, the former of the light-armed.

ARMENIA, an extensive country of Western Asia, divided at present between Turkey, Russia, and Persia. It extends from the Caucasus on the north, to the mountains of Kurdistan on the south; and from the Euphrates on the west, nearly to the Caspian Sea on the east; being thus between Lat. 37. and 42. N. and Long. 39. and 50. E. The boundaries of this country, however, have been very fluctuating, and at no time exactly defined. Its area is estimated at about 90,000 square miles, and the population at 2,000,000. It forms an elevated table-land, sinking towards the plains of Iran on the east, and those of Asia Minor on the west. Its plains are elevated 7000 feet above the level of the sea, while the gigantic Ararat rises to the height of 17,260 feet. From Ararat lofty ridges, intersected by deep valleys, diverge in various directions. Armenia is well watered and fertile, producing grain, cotton, tobacco, grapes, and other fruits; and abounds in romantic mountain and forest scenery, and rich pasture land. Its principal rivers are the Euphrates, the Tigris, the Aras, and the Kur, all of which have their sources in Armenia. The climate, from the elevation of the country, is generally cold, but not unhealthy. The largest of its lakes is the Van, whose circumference is estimated at 240 miles. The Sevan and Urmia Lakes are also of considerable extent, and the waters of the latter are remarkable for their saltness. Armenia is mentioned by ancient authors as abounding in metals and precious stones; and its mines of iron, copper, silver, lead, and other metals, are still wrought.

Under the name of Armenia, ancient writers included a considerable part of Asia Minor, to which was afterwards given the name of Armenia Minor.

The Armenians call themselves *Haiks*, and their country *Hayotz-zor*, the valley of the Haiks, from Haik, the fifth in descent from Noah by Japhet, according to the traditionary genealogy of the country. They are active, industrious, and hospitable; and are a handsome race, the women especially being noted for the delicacy and regularity of their features. The Armenians now form only about a seventh part of the population of Armenia, the rest of its inhabitants being chiefly Turks and Kurds. From the persecutions and tyranny to which they have been exposed, most of them have left their country, and though originally a brave and warlike people, they have become distinguished for their peaceful character, and their submissiveness to the government of every country in which they live. Devoted to trade and manufactures, they have prospered wherever they have settled; and their scattered colonies now extend from Hungary and Venice to Calcutta, and even to China, and from St Petersburg and Moscow to the deserts of Africa. They generally live in large families, under the patriarchal rule of the oldest member. Their religion is a branch of the Oriental Church. They have few holidays, and condemn the worship of images. Their spiritual concerns are superintended by four patriarchs, of whom the principal, called the Catholicos, resides at the convent of Etchmiadzin, near Erivan. One resides at Sis in Caramania; another at Gand sasar, near the Lake of Erivan; and the fourth at Achtamar, an island in the Lake of Van. Some Armenians have united with the Church of Rome, and have two archbishops, one at Nachshivan on the Don, and the other at the Island of San Lazaro, in the lagunes of Venice.

The early history of Armenia, like that of most other countries, is involved in obscurity. According to the Armenian account, the first ruler of the country was Haik the son of Togarmah, mentioned in Gen. x. 3. as the grandson of Japhet. He is said to have left Babylon to escape the tyranny of Belus king of Assyria, and to have established himself and his family in Armenia. Belus pursued him thither, but was defeated and slain by Haik about twenty-one centuries before the Christian era. Four centuries later reigned Ara, the seventh in descent from Haik, who having incurred the hatred of Semiramis queen of Assyria, was slain in a battle with that nation, and his kingdom became an Assyrian province, although it still continued to be governed by its own princes. From this time Armenia remained subject to Assyria till about the middle of the eighth century B.C. Barvir, who was then ruler, joined the Medes and Babylonians in their revolt against Sardanapalus, and Armenia recovered its independence. Tigranes or Dikran, who flourished about two centuries later, was the friend and ally of Cyrus, and is said to have rendered that monarch great assistance in his contest with Astyages king of the Medes. According to the Armenians, this is the Tigranes who built the city of Tigranocerta. He was succeeded by his son Vahakin, the Hercules of the Armenians, who was celebrated in song and story for his prowess and exploits, and received deification after death. The last of the Haik dynasty was Vahi, who was king of Armenia in the time of Alexander the Great. He took part with Darius against the Macedonians, but was defeated and slain. Armenia thus fell into the hands of the conqueror; and Mithrenès, a Persian, was appointed governor of the country. Taking advantage of the dissensions which followed the death of Alexander the Great, the Armenians threw off the Macedonian yoke, about B.C. 317. Ardvates was chosen king; but on his death, about 33 years afterwards, they were obliged to submit to the Syrians. About B.C. 190, when Antiochus the Great was defeated by the Romans, Artaxias and Zariadris, two Armenian nobles, took advantage of the moment to free their country from the Syrian yoke. Artaxias obtained possession of Armenia-Major, and Zariadris of Armenia-Minor, which his descendants continued to hold till the Sophenian Artanes was conquered and deposed by Tigranes II. king of Armenia-Major, who annexed it to his dominions. The descendants of Artaxias reigned in Armenia till their expulsion by the Arsacidæ. About the middle of the second century B.C., Mithridates I., of the race of the Arsacidæ, was king of Parthia. He greatly extended the bounds of his empire, conquered Syria, and established his brother Wagharshag in Armenia, B.C. 149. With him commenced the dynasty of the Arsacidæ in that country. Wagharshag greatly promoted the prosperity of his kingdom by founding cities, establishing laws, and rewarding persons of talent. His great-grandson, Tigranes II., the most celebrated of the family, ascended the throne in the year 89 B.C. He conquered Artanes king of Sophene, besides several other petty chiefs, and annexed their dominions to his own. He wrested from the Parthians several of their provinces, and made himself master of Syria, and was so elated with successes, that he assumed to himself the title of King of kings.

Incited by his father-in-law Mithridates king of Pontus, who was anxious to engage him in a war with the Romans, he marched into Cappadocia, and returned loaded with booty, besides no fewer than 300,000 captives, whom he employed in building the city of Tigranocerta, which they afterwards peopled: the Armenian historians, however, state that it was Tigranes I. who founded his city. After the defeat of Mith-

ridates he took refuge with Tigranes, who, though he manifested no inclination to espouse his cause, was so much offended at the haughty manner of the Roman messenger sent to demand the fugitive, that he returned a peremptory refusal. Lucullus, the Roman general, immediately invaded Armenia, defeated the forces sent against him, and took Tigranocerta. In the following year (B.C. 68) the combined forces of Tigranes and Mithridates were totally routed; but the mutinous disposition of the Roman troops prevented Lucullus from following up his success, and Tigranes recovered the greater part of his lost dominions. The arrival of Pompey, however, in 66, soon changed the aspect of affairs; and Mithridates, who had succeeded in establishing himself in his former possessions, was again obliged to take refuge in Armenia. Tigranes in the meantime had another enemy to encounter in the person of his son, who being detected in a conspiracy against his father, sought the protection and assistance of the Parthian king. That monarch invaded Armenia with a considerable force, but was soon obliged to retire, and the young Tigranes applied to the Romans for assistance. It was at this time that Mithridates implored the protection of his son-in-law; but Tigranes suspecting him of having aided the designs of his son, not only refused to receive him, but set a price upon his head, and hastened to supplicate Pompey who was entering his kingdom under the guidance of the young Tigranes. He succeeded in obtaining peace, and was allowed to keep possession of Armenia, with the exception of the provinces of Sophene and Gordyene, which were erected into a separate kingdom for his son Tigranes; and from this time he remained a faithful ally of the Romans. He afterwards engaged in war with the king of Parthia, but their differences were settled by the mediation of Pompey. He is supposed to have died about B.C. 55, and was succeeded by his son Artavasdes. This monarch, having deserted the cause of the Romans, was taken prisoner by Antony and carried to Alexandria, where he was afterwards beheaded by Cleopatra in B.C. 30; and Armenia became tributary to the Romans.

About the commencement of the Christian era, Abgarus was king of Armenia. On his death the kingdom was divided between his son Anane and his nephew Sanadroug; but the ambitious Sanadroug expelled Anane, and took possession of the kingdom. Sanadroug was succeeded by the usurper Erowant, an Arsacid by the female line, who made himself master of the kingdom about A.D. 58. He extirpated the family of his predecessor, with the exception of the infant Ardaches, who was placed in concealment, and carried to the court of Persia. When Ardaches arrived at manhood, with the assistance of some of the neighbouring princes he deposed and slew the tyrant, and obtained possession of the kingdom. Ardaches was a brave and martial prince, and conquered the Alani of the Caucasus, and some other races; but his reign was generally tranquil, and he did much to ameliorate the condition of his subjects by the establishment of schools and other useful institutions.

When the Arsacidæ were expelled from the Persian throne (A.D. 226), Chosroes I., surnamed the Great, was king of Armenia. Being allied to the expelled family, he naturally took up arms in their defence; and marching against the usurper Ardashir he defeated him in battle. Chosroes, shortly after, was assassinated by Anag at the instigation of Ardashir, and Armenia became subject to Persia, A.D. 232.

In the massacre of the royal family which ensued, none escaped but Tiridates, a son of Chosroes, who fled to Rome; and afterwards, with the assistance of the Romans, succeeded in establishing himself upon the throne, A.D. 259. The first act of his reign was the persecution of the Christians. St Gregory, surnamed the Illuminator, was cast into prison; but the king being miraculously cured of a dangerous distemper by that saint, he and most of his people embraced the Christian religion. The introduction of Christianity tended to arouse the animosity of the Persians; and from this period Armenia became the theatre of almost uninterrupted struggles between the Romans and Persians, until Theodosius the Great agreed to cede to Persia the eastern part of the country, which was hence called Persarmenia, while the western part was attached to the Roman Empire. Theodosius nominated Arsaces IV., then king of Armenia, governor of the western division; and the Persian king, in order to conciliate the people, appointed Chosroes III., a descendant of another branch of the Arsacidæ, governor of the eastern part. On the death of Arsaces IV. his dominions were conferred on the commander Cazavon; and the rule of the Arsacidæ in Persarmenia ended with Ardasches IV. who was dethroned by the Persian king Bahram V. in 428. From that time Armenia ceased to be a kingdom, and till 632 it was ruled by Persian governors. From the time that the Persians obtained a footing in Armenia they strenuously endeavoured to subvert Christianity, and to establish Paganism in its stead. For that purpose they had recourse to the most cruel persecutions, and frequent insurrections were the consequence. From 632 till 859 Armenia was the scene of almost incessant struggles between the Greeks and Mohammedans, and it became by turns subject to each. At the latter date the dynasty of the Pagratidæ, who had settled in Armenia at an early period, came into power. This family was of Jewish origin, and had risen to be one of the most powerful in that country. Ashod, one of this family, so gained the confidence of the khalif as to be declared king of Armenia in 885, and his title was afterwards recognized by the Greeks. He reigned thirty-one years; and his descendants maintained their authority in Armenia till 1079, when Gagik was treacherously murdered by the Greeks, and the greater part of the country became dependent on the Grecian empire. Koussen, a relative of the late king, founded a small principality in the Taurus Mountains, north of Cilicia, which gradually extended its boundaries to the Mediterranean. The princes of this house allied themselves with the European monarchs in the crusades. This kingdom maintained its independence till the year 1375, when the last king Leon VI. was taken prisoner by the Mamelukes of Egypt. After a captivity of six years he obtained his liberty, and wandered through Europe from one country to another till the time of his death, which took place at Paris in 1393. In 1583 Armenia was overrun by the Ottomans, who treated the people with such cruelty that great numbers of them took refuge in Persia and other countries. In 1604 Shah Abbas made an incursion into Armenia, and carried off a great part of the inhabitants; and from that time Armenia lost every shadow of nationality and independence. The greater part of the country was annexed to Turkey, and divided into pashalics; while the eastern part remained subject to Persia. Since the commencement of the present century, Russia has, from time to time, acquired considerable portions of this territory; and at present Armenia forms the Turkish pashalics of Erzeroom, Trebizond, Diarbekir, Kars, and Van, part of the Persian province of Azerbijan, and the Russian government of Transcaucasia; Mount Ararat being, as it were, the central boundary-stone between them. —See *Historiæ Armeniacæ*, by Moses of Chorene; *Memoires Historiques et Geographiques sur l'Armenie*, par M. Saint Martin; *History of the Vartan*, translated by Neumann; *Journal of the Geographical Society;* Kinneir's *Memoirs of the Persian Empire, and Travels in Armenia;* Ker Porter's *Travels*, &c.

ARMENIAN LANGUAGE. The translation of the Bible by Miesrob is the earliest monument of the Armenian or Haikan language that has come down to us. The dialect in which this version is written, and in which it is still publicly read in their churches, is called the old Armenian. The modern Armenian not only departs from the elder form by dialectual changes in the native elements of the language itself, but also by the great intermixture of Persian and Turkish words which has resulted from the conquest and subjection of the country. It is, perhaps, this diversity of the ancient and modern idioms which has given rise to the many conflicting opinions that exist as to the relation in which the Armenian stands to other languages. Thus Cirbied and Vater both assert that it is an original language, that is, one so distinct from all others in its fundamental character as not to be classed with any of the great families of languages. Eichhorn, on the other hand, affirms that the learned idiom of the Armenian undoubtedly belongs to the Medo-Persian family. Whereas Pott says that, notwithstanding its many points of relation to that family, it cannot strictly be considered to belong to it; and Gatterer actually

classed it as a living sister of the Basque, Finnish, and Welsh languages.

As to form it is said to be rough, and full of consonants; to possess *ten* cases in the noun—a number which is only exceeded by the Finnish; to have no dual; to have no mode of denoting gender in the noun by change of form, but to be obliged to append the words *man* and *woman* as the marks of sex—thus to say *prophet-woman* for *prophetess* (nevertheless, modern writers use the syllable *ouhi* to distinguish the feminine); to bear a remarkable resemblance to Greek in the use of the participle and in the whole syntactical structure; and to have adopted the Arabian system of metre.

Until the third century of our era, the Armenians used either the Persian or Greek alphabet. In the fifth century, however, the translation of the Bible created the necessity for characters which would more adequately represent the peculiar sounds of the language. Accordingly, after a fruitless attempt of a certain Daniel, and after several efforts on his own part, Miesrob saw a hand in a dream write the very characters which now constitute the Armenian alphabet. The 38 letters thus obtained are chiefly founded on the Greek, but have partly made out their number by deriving some forms from the Zend alphabet. The order of writing is from left to right. Miesrob employed these letters in his translation of the Bible, and thus ensured their universal and permanent adoption by the nation. (Gesenius; article *Palæographie,* in Ersch and Gruber.) (J. N.)

ARMENIAN VERSION. The Armenian version of the Bible was undertaken in the year 410 by Miesrob, with the aid of his pupils Joannes Ecelensis and Josephus Palnensis. It appears that the patriarch Isaac first attempted, in consequence of the Persians having destroyed all the copies of the Greek version, to make a translation from the Peshito; that Miesrob became his coadjutor in this work; and that they actually completed their translation from the Syriac. But when the above-named pupils, who had been sent to the ecclesiastical council at Ephesus, returned, they brought with them an accurate copy of the Greek Bible. Upon this Miesrob laid aside his translation from the Peshito, and prepared to commence anew from a more authentic text. Imperfect knowledge of the Greek language, however, induced him to send his pupils to Alexandria, to acquire accurate Greek scholarship; and, on their return, the translation was accomplished. Moses of Chorene, the historian of Armenia, who was also employed, as a disciple of Miesrob, on this version, fixes its *completion* in the year 410; but he is contradicted by the date of the Council of Ephesus, which necessarily makes it subsequent to the year 431.

In the Old Testament, this version adheres closely to the LXX. (but, in the Book of Daniel, has followed the version of Theodotion). Its most striking characteristic is, that it does not follow any known recension of the LXX. Although it more frequently agrees with the Alexandrine text, in readings which are peculiar to the latter, than it does with the Aldine or Complutensian text; yet, on the other hand, it also has followed readings which are only found in the last two. Bertholdt accounts for this mixed text by assuming that the copy of the Greek Bible sent from Ephesus contained the Lucian recension, and that the pupils brought back copies according to the Hesychian recension from Alexandria, and that the translators made the latter their standard, but corrected their version by aid of the former. The version of the New Testament is equally close to the Greek original, and also represents a text made up of Alexandrine and Occidental readings.

This version was afterwards revised and adapted to the Peshito, in the sixth century, on the occasion of an ecclesiastical union between the Syrians and Armenians. Again, in the thirteenth century, an Armenian king, Hethom or Haitho, adapted the Armenian version to the Vulgate, by way of smoothing the way for a union of the Roman and Armenian churches. Lastly, the bishop Uscan, who printed the first edition of this version at Amsterdam in 1666, is also accused of having interpolated the text, by adding all that he found the Vulgate contained *more* than the Armenian version. The existence of the verse 1 John v. 7, in this version, is ascribed to this supplementary labour of Uscan. It is clear from what has been said, that the critical uses of this version are limited to determining the readings of the LXX. and of the Greek text of the New Testament which it represents, and that it has suffered many alterations which diminish its usefulness in that respect. (J. N.)

ARMENTIERES, a small handsome town in the department Du Nord, in France, containing 6675 inhabitants. It was taken in 1667 by Louis XIV., who dismantled it. The river Lys traverses the town, and forms a small harbour. Its principal manufactures are cotton, linen, lace, thread, and sailcloth. Long. 3. 3. E. Lat. 50. 40. N.

ARMIGER, a title of dignity belonging to such gentlemen as bear arms; and these are either by courtesy, as sons of noblemen, eldest sons of knights, &c.; or by creation, such as the king's servants, &c. See ESQUIRE.

ARMILLARY SPHERE. See GEOGRAPHY, *Globes.*

ARMINIANS, a religious sect, which arose in Holland, by a separation from the Calvinists. They followed Arminius, who, thinking the doctrine of Calvin with regard to free-will, predestination, and grace, too severe, began, in the year 1591, to express his doubts concerning them; and upon further inquiry adopted sentiments more nearly resembling those of the Lutherans. After his appointment to the theological chair at Leyden, he thought it his duty to avow and vindicate the principles which he had embraced; and the freedom with which he published and defended them exposed him to the resentment of those that adhered to the theological system of Geneva, which then prevailed in Holland; but his principal opponent was Gomar, his colleague. The controversy which was thus begun became more general after the death of Arminius, in the year 1609, and involved the United Provinces in civil discord. The Calvinists, or Gomarists as they were now called, appealed to a national synod. Accordingly the synod of Dort was convened by order of the States General, in 1618, and was composed of ecclesiastical deputies from the United Provinces, as well as from the reformed churches of England, Hessia, Bremen, Switzerland, and the Palatinate. The principal advocate in favour of the Arminians was Episcopius, who at that time was professor of divinity at Leyden. It was first proposed to discuss the principal subjects in dispute, and that the Arminians should be allowed to state and vindicate the grounds on which their opinions were founded: but some difference arising as to the proper mode of conducting the debate, the Arminians were excluded from the assembly, their case was tried in their absence, and they were pronounced guilty of pestilential errors, and condemned as corrupters of the true religion. In consequence of this decision they were treated with great severity, deprived of all their posts and employments, their ministers silenced, and their congregations suppressed. However, after the death of Prince Maurice, who had been a partisan of the Gomarists, in the year 1625, the Arminian exiles were restored to their former tranquillity; and, under the toleration of the state they erected churches and founded a college at Amsterdam, appointing Episcopius to be the first theological professor. The Arminian system has very much prevailed in England since the time of Archbishop Laud, and its supporters in other countries are numerous.

The Arminians are also called *Remonstrants,* from a humble petition, entitled their *Remonstrance,* which, in the year 1610, they addressed to the states of Holland. Their principal writers are Arminius, Episcopius, Vorstius, Grotius, Curcellæus, Limborch, Le Clerc, and Wetstein; not to mention many others of more modern date.

ARMINIUS, a celebrated German chief. See GERMANY.

ARMINIUS, *Jacobus,* whose real name in Low Dutch was James Hermanni, a famous Protestant divine, was born at Oude Water, in Holland, in 1560. He was ordained minister at Amsterdam on the 11th of August 1588, where he

soon distinguished himself by his sermons, which were remarkable for their solidity and learning. Martin Lydius, professor of divinity at Franeker, judging him a fit person to refute a polemic in which Beza's doctrine of predestination had been attacked by some ministers of Delft, Arminius at his desire undertook the task; but upon thoroughly examining the reasons on both sides, he adopted the opinions he proposed to overturn, and afterwards went still farther than the ministers of Delft had done. In 1600 he opposed those who maintained that ministers should subscribe the confession and catechism every year. During a pestilential disease which raged at Amsterdam in 1602, he acted with the greatest resolution and courage, in assisting the poor and comforting the sick; and Lucas Trelcatius and Francis Junius dying of that disease at Leyden, the curators of that university chose Arminius professor of divinity there. He was afterwards made doctor of divinity. Disputes upon grace were kindled in the university; and he was likewise involved in a new contest occasioned by a disputation of his concerning the divinity of the Son. These contests, his continual labour, and the vexation at seeing his reputation blasted by slanders in relation to his opinions, impaired his health, and threw him into a fit of sickness, of which he died on the 19th of October 1609. Arminius was esteemed an excellent preacher: his voice was low, but very agreeable; his pronunciation admirable; he was easy and affable to persons of all ranks, and facetious in conversation amongst his friends. The curators of the university of Leyden had so great a regard for him that they settled a pension upon his wife and children. His several treatises, collected in a 4to volume, were published at Leyden in 1629, and have been frequently reprinted.

ARMISTICE, in *Military Affairs*, a temporary truce or cessation of arms for a very short space of time. The word is compounded of *arma*, arms, and *sisto*, to stop or cause to stand still.

ARMLET, an ornament which is worn on the upper arm. In the East, bracelets are generally worn by women, and armlets only by men. The armlet, however, is only in use among men as one of the insignia of sovereign power. The Egyptian kings are represented with armlets, which were also worn by the Egyptian women.

ARMORIC, or AREMORIC, something that belongs to the province of Bretagne or Britany, in France. The name *Armorica* was anciently given to all the northern and western coast of Gaul, from the Pyrenees to the Rhine, under which name it was known even in Cæsar's time. The word is of Bas-Breton origin, and signifies *maritime;* compounded, according to M. Menage, of *ar*, upon, and *môr*, sea.

ARMORY, a storehouse of arms, or a place wherein military habiliments are kept ready for use. There are armories in all arsenals, citadels, castles, &c.

ARMOUR, a defensive habit, wherewith to cover and secure the body from the attacks of an enemy. In ancient statutes this is frequently called *harness*. A complete armour anciently consisted of a casque or helm, a gorget, cuirass, gauntlets, tasses, brassets, cuisnes, and covers for the legs, to which the spurs were fastened. This formed armour *cap-à-pié*, and was used by the cavaliers and men-at-arms. The infantry had only part of it, viz., a pot or head-piece, a cuirass, and tasses; but all light. Lastly, the horses themselves had their armour, wherewith to cover the head and neck. Of all this furniture of war, scarce anything is now retained except the cuirass and helmet; the gorget or neck-piece, which was latterly a mere ornament, and of no defence, being no longer used.—See Meyrick's *Ancient Armour*.

ARMS, ARMA, in a general sense, includes all kinds of weapons, whether for defence or offence. See ARMY.

ARMS, or *Armories*, in *Heraldry*, marks of dignity composed of certain figures and colours, and borne on banners, shields, &c., for the distinction of persons, families, and states. See HERALDRY.

ARMSTRONG, JOHN, M.D., a physician, poet, and miscellaneous writer, the friend of Thomson, Mallet, and Wilkes, was born about the year 1709, in Castletown parish, Roxburghshire, where his father and brother successively were ministers of the Scottish church. He completed his education at the University of Edinburgh, where he took his degree in Physic, Feb. 4. 1732, with much reputation. His professional success, however, does not seem to have been at any time considerable, as he probably paid more attention to literary than to medical labours. He took up his residence in London, and in 1746 was appointed one of the physicians to the Hospital for lame and sick soldiers behind Buckingham House. In 1760 he was appointed physician to the army in Germany, which appointment he held till the peace of 1763. In a poetical epistle to John Wilkes in 1761, he drew upon himself the enmity of the satirist Churchill, and afterwards quarrelled with Wilkes himself. His latter years seem to have been embittered by disappointments, as is evinced by the tone of his writings, in which he particularly directs his sarcasms against his medical brethren and the reviewers. He died in 1779, and was found, notwithstanding his want of professional success, to have saved upwards of L.3000.

Dr Armstrong's first publication was a humorous pamphlet, entitled *An Essay for Abridging the Study of Physic, &c.*, containing much clever and well-directed satire. It appeared anonymously in 1735. Of his numerous subsequent essays, sketches, and poems, the only one by which he is now remembered is his didactic poem, entitled *The Art of Preserving Health*, first published in 1744. As a poetical composition, its value is but small. It contains, however, some passages of considerable merit; and, considering the nature of the subject, is perhaps as successful a performance as could have been expected. His smaller pieces, including *Benevolence*, a poetical epistle; *Taste*, an epistle to a young critic; *Sketches by Launcelot Temple, Esq., &c.*, were published along with the *Art of Preserving Health*, in 1770, under the title of *Miscellanies*. They generally display much humour and acuteness of observation.

ARMSTRONG, *John*, M.D., an eminent physician and medical writer, was born in 1784, at Bishop Wearmouth in Durham. Having received some preliminary education, he completed his studies at the University of Edinburgh, where he obtained his medical degree in 1807. He then became a candidate for practice in his native place, but soon afterwards removed to Sunderland, where he engaged in extensive practice, and became physician to the dispensary in that town. This situation he resigned in 1817, and settled in London, where the reputation he had already acquired by his writings prepared the way for his future success. As a lecturer, also, in the Webb Street School at London, Dr Armstrong was highly popular. His lectures, edited by Joseph Rix, were published in 1834 in one volume 8vo. His principal work is that entitled *Practical Illustrations of Typhus Fever and other Febrile and Inflammatory Diseases*, which was published in 1816. Dr Armstrong died of pulmonary consumption in 1829. He is represented as a man of estimable character,—yet it is to be regretted that he had the temerity to depreciate such men as Mead, Cullen, and Heberden; though their reputation indeed, stands too high to be affected by such criticism.

ARMUYDEN, a seaport town of the United Provinces, in the island of Walcheren, formerly very flourishing, but now inconsiderable. Pop. 1340. Long. 3. 40. E. Lat. 51. 30. N.

ARMY.[1]

Army.

Definitions.

An army, says Dr Johnson,[2] is "a collection of armed men obliged to obey one man." This definition, however, has little else than its brevity to recommend it. An army, it is true, is "a collection of armed men," and such a "collection" is generally "obliged to obey one man," that is to say, it is commonly placed under the exclusive control and direction of an individual chief or leader. But it does not follow that "a collection of armed men obliged to obey one man" is the distinguishing or principal characteristic of an army, since a gang of robbers or banditti would equally answer this description. To be at all applicable, therefore, the definition of army must be at once more comprehensive and more precise; in other words, it must include the specification of those peculiar circumstances or attributes, the aggregate of which constitutes the complex idea sought to be resolved. Hence an army may, we think, be more accurately defined, a certain portion of the community selected, raised, or assembled, for the defence of the state, by means of conscription, voluntary enrolment, tenure of military service, or otherwise; armed, disciplined, and organized, conformably to a given system, which is considered best calculated for giving full development and efficacy to its collective force; and commanded by a chief or leader, with subordinate officers in regular gradation, to carry his orders into effect, and move the living machine, thus constructed, as he shall think proper to direct. It is an artificial or scientific combination of a great number of powers, individually small or insignificant, so as, by their union and concentration, to accomplish mighty and important deeds; a force which states and nations create out of the elements of their strength, as mechanicians form engines by taking advantage of and skilfully combining the action of the primary mechanical powers; an instrument, in short, so contrived as, though originally intended for the best, to be equally available for the worst purposes, being alike fitted for defence or aggression, for protection or conquest, for restraining and punishing the dishonest ambition of others, or affording the means of gratifying our own. An army, therefore, may be considered a species of movable engine, composed of a vast number of individual parts or powers, so arranged and organized as not only to act in concert, but to exert their whole aggregate force in any direction and upon any point which may be ordered or required. At the present day this denomination is applied to any given number of soldiers, consisting of artillery, infantry, and cavalry, of various descriptions, all completely armed and provided with engineers, a train of artillery, ammunition, magazines, commissariat, and other necessary adjuncts, subject to the command of a general, having under him lieutenant-generals, major-generals, brigadier-generals, colonels, majors, captains, and subalterns:[3] And an army is now composed of battalions or squadrons, regiments, brigades, divisions, and sometimes corps d'armée; two or more battalions or squadrons forming a regiment, two or more regiments a brigade, two or more brigades a division, and two or more divisions a corps d'armée. So much for definition and description.

General observations.

Were we called upon to trace to its origin the history of war, we should find it necessary to ascend through every form and gradation of society to the very cradle of the human race. Admitted on all hands to be one of the greatest evils, war is also, unhappily, one of the oldest. "Il est triste d'imaginer," says a celebrated military writer, "que le premier art qu'aient inventé les hommes, ait été celui de se nuire, et que, depuis le commencement des siècles, on ait combiné plus de moyens pour détruire l'humanité que pour la rendre heureuse."[4] This is a truth which cannot be disputed. The passions of rivalry, jealousy, hatred, revenge, cupidity, thirst of power or ambition, were born with the world; and these, in their turn, gave birth to war, which again produced the desire of conquering or combating with success. But, in proportion as this desire came to prevail, men would naturally be led to reflect as to the means best fitted to insure its gratification: and as experience must soon have convinced them that the battle was not always to the strong, nor the race to the swift,—or, in other words, that mere brute force, openly applied, was in many cases insufficient to secure the victory, and, in most, productive of a loss that countervailed it,—they must early have discovered that some degree of combination was requisite, and certain extrinsic qualities necessary, to render it effectual; that violence might find an auxiliary in cunning, and resistance be paralysed by stratagem and surprise. Such, accordingly, is the state of things which generally obtains amongst savage tribes, however warlike and enterprising. They seldom go down to battle openly and boldly; nor do they consider victory, when dearly purchased, as either honourable or desirable. Artifice is their main resource. The first principle of their simple tactics is to steal unperceived upon the enemy, and overwhelm him, while unsuspicious of attack and unprepared for resistance. In this and similar principles, however, we discover the origin and primary development of the military art. Its source is in the forest or the wilderness. But as war is the first art which men invented, so it is also that which was soonest cultivated and improved. It kept pace with the progress of society;—as mankind multiplied, and communities extended themselves, it received a corresponding expansion;—more means were combined, and a greater number of men were assembled. This was the second stage of the art, where it remained long stationary, and in nearly the same state in which we find it at the present day among some of the Asiatic nations. Science had not digested nor systematized the rude and shapeless mass of knowledge which experience had supplied, or suggested new combinations of existing means. But ambition at length gave a fresh stimulus to improvement, by opening up a new theatre for its expansive energies; and successive conquerors contributed largely to the cultivation of an art which became the instrument of their glory. In their hands, accordingly, it determined the destiny of nations;—it raised up or destroyed empires;—it produced mighty revolutions;—it overthrew old dynasties, and created new ones in their stead;—and, amidst all the havoc and desolation occasioned by the pursuit of false glory, it contributed, upon the whole, to the cultivation of those sciences and arts which have a tendency to mitigate the natural ferocity of man, and ultimately to render conquest itself less destructive, and war less sanguinary.

Army.

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[1] The important changes effected in the organization and establishment of the British army since the war of 1854, have of course deprived the following article of the strict accuracy which it originally possessed. As these improvements are still in progress, moreover, and are likely to continue for some considerable time, it has been found impossible to make the details respecting the British army in all respects as accurate as could be desired. (*Note* of 1858.)

[2] *Dictionary, voce* Army.

[3] James's *Military Dictionary, voce* Army.

[4] *Essai Général de Tactique*, par Guibert, vol. i., p. 59, *Disc. Prélim.*, Paris, 1803.

Results so vast leave no doubt whatever, that the art which was principally instrumental in producing them, must have made considerable progress at a very remote period of the world. It is in fact in the early and semi-barbarous stage of society that the military virtues are found in the greatest perfection. The mind is then fierce, ardent, energetic, and daring; peculiarly accessible to the illusion of warlike renown, and undistracted by any of those influences or impressions which act so powerfully upon man in civilized life; while the body, unpampered by luxury, unenfeebled by indulgence, is a fit companion for such a spirit, and capable of enduring, without difficulty, the fatigues and privations incident to war. Add to this that, at the period of which we speak, the only law generally recognised and respected is the law of the strongest; that the necessity of self-defence, of protecting person and property from violence and spoliation, keeps men continually prepared to repel force by force, or to retaliate one aggression by another; that, consequently, the disorders which distract society re-act upon and foster the turbulent spirit in which they have their origin; that war thus becomes a trade which all are either disposed or compelled to pursue; that, to bold and adventurous spirits, it opens up the only path which leads to fortune and to fame, and thus holds out irresistible temptations to embark in military enterprises. At such a period all men are soldiers, and war is their natural employment; in it they live and move and have their being. But necessity is the parent of invention, and the mother of arts; and to it the science of war was indebted for its first improvements. Armies are unwieldy machines, which cannot be moved without some degree of organization, nor supported without considerable care and foresight, nor led into action with an enemy without a certain knowledge of tactical combinations. It is obvious, therefore, that wherever we read of such masses of men having been assembled, whether for purposes of aggression or defence, we may safely consider this fact as of itself conclusive, that the military art had there reached the second stage of its progress, or, in other words, had made considerable advances. History may be silent as to the precise extent to which improvement had been carried, and the records of the past may afford no clue to direct our inquiries concerning the composition and organization of the armies of remote antiquity; but if it be once admitted that such armies existed, and that they defended some countries and overran or conquered others, this admission will imply no inconsiderable knowledge of the art of war on the part of those by whom they were organized and directed. Discipline of some kind or other is the bond which keeps together large bodies of men: without it they are a mere mob or rabble, incapable alike of action or direction, and formidable to none save the people of the country where they happen to have congregated. Even the Tartar hordes of Genghis Khan and Timour had an organization and discipline of their own, by means of which these barbarian conquerors were enabled to impel their fierce and warlike masses against the enfeebled and effeminate soldiery of countries advanced in wealth and in civilization;[1] and the same observation applies still more forcibly to the Asiatic and Turkish armies of our own time. In a word, we may adopt with some qualification the remark of Guibert, when speaking of the progress of the military art: "Il précéda," says he, "chez tous les peuples, les arts et les sciences, et y périt à mesure que celles-ci s'étendirent."[2] The details into which we are about to enter will fully illustrate the truth of these general observations.

Ancient Egyptian army.

The earliest military establishment of which history has preserved any record is that of Egypt under the reign of Sesostris, or, as he is denominated in the monumental sculptures of that wonderful country, Rhamses;[3] who was considered the greatest of the Egyptian kings after Osiris,[4] and has generally been supposed by chronologists to have flourished about seventeen centuries before our era.[5] But Osiris was an ideal being, the offspring of mythology, and the hero of fable, adored by the Egyptians sometimes as a deified mortal, sometimes as a personification of the Nile, and sometimes as the symbolical representative of the solar orb. Sesostris, on the contrary, is claimed by history as a real personage; and although the accounts which have been preserved of the reign of this prince, chiefly by the Greek historians, are dashed with a considerable admixture of exaggeration and romance, we cannot reasonably doubt the existence of the monarch, however we may be inclined to question the exploits of the hero and the achievements of the conqueror. The substance of these accounts, indeed, when considered in connection with the corroborative evidence supplied by the Egyptian monuments, and the traces of his expedition which remained even in the age of Herodotus, may be regarded as the more deserving of credit that, while scepticism has little to oppose to them except its own incredulity, the statements of the Greek historians are not only consistent with one another, but in strict accordance with the uniform tradition and belief, as well as with the records, of that country, the mother of arts and civilization, which, under this renowned

[1] Timour or Tamerlane, of whom unfortunately we know so little, has left an institutional or elementary treatise on war and the art of conducting armies, each page of which affords proof of a natural genius for commanding men, as well as of tact and skill in employing them to the best advantage. See *Instituts de Timour*, par Langlès; also Jomini, *Traité des Grandes Opérations Militaires*, tome viii. p. 678. Paris, 1616.

[2] *Essai Général de Tactique*, vol. i. p. 60.

[3] One of the difficulties which occur in our inquiries concerning Sesostris arises from the different names by which he has been designated by ancient writers. He has been variously called Sesostris, Sesoosis, Sesochis, Sesonchosis, Sethosis, Sethos, Ramesses, Rameses, Rhamses, Ramestes, Rampses, Vexores, and Ægyptus. But most of these appellations were probably titular. Thus, *Sesostris* may be SE-SIOS-T-RE, which signifies, *filius domini, donum solis*; *Sesoosis* may, in like manner, be a corruption for SE-SIOS-SIOS, *filius domini dominorum*; and *Rhamses* or *Ramesses*, derived from RE, *sol*, and MES, *gignere*, may signify *Begotten by the Sun*. But it is not always possible to render ancient Egyptian names according to the grammatical rules established in the Coptic language, and, therefore, such etymologies as those now proposed are to be received as purely conjectural. The common designation of this monarch on the monuments is RAMESES-MEIAMOUN, *Rhamses beloved of Ammon*; or, adopting the etymology of *Rhamses* just proposed, *Begotten by the Sun, Beloved of Ammon*; in which case both appellations would be merely titular. *Vide* Sir W. Drummond's *Origines*, book iv. chap. 13, and Champollion's *Précis du Système Hiéroglyphique*, p. 223. Paris, 1824.

[4] Manetho *apud Euseb. Chron.* lib. i. In Manetho *apud Josephum contra Appionem*, lib. i. p. 1053, this monarch is indifferently called *Ramesses* and *Rampses*.

[5] Chronologists have been unable to fix the precise date of the reign of Sesostris. Larcher, the celebrated translator of Dionysius of Halicarnassus, adopts and defends with much warmth the chronography of Herodotus; while others, rejecting the authority of the father of history, endeavour to determine the era of the Egyptian monarch from the scanty data furnished by Diodorus and Strabo. The objections to the conclusions of Larcher, stated by Sir William Drummond in his *Origines*, book iv. chap. 13, appear to be perfectly unanswerable.

sovereign, is supposed to have reached an unprecedented height of military glory.

Sesostris, however, did not create the military spirit to which he appears afterwards to have given such ample development. This was in a great measure the work of his father, Amenophis III., who, shortly after the birth of his son, is said to have assembled all the male children born on the same day, and to have given them the same education. No distinction was made between the young prince and his companions. They were alike engaged in the same studies, trained to the same exercises, inured to the same hardships, and instructed in the use of the same arms. A rigid discipline prescribed unremitting exertion, while daily privations and fatigue hardened and prepared them for the duties of war. In establishing this military seminary, Amenophis appears to have intended placing around his son a faithful band of soldiers, attached to him by the associations of early friendship, and the ties of brotherhood in arms. Nor did the result disappoint his expectations. Arrived at manhood, the prince and his companions soon evinced how much they had profited by their education,—how well they merited the confidence reposed in them. With bodies rendered vigorous and athletic by labour and exercise, and with minds cultivated by the best studies, they were already fitted to act both as soldiers and as generals, to serve with energy, or to command with skill. Sent by his father at an early age to command an expedition against the Arabians, the prince, accustomed, as well as his companions, to suffer long both from hunger and from thirst, could meet upon equal terms the wandering and yet unconquered tribes, who chiefly trusted for their defence to the barrenness of their inhospitable deserts. Arabia was subdued and annexed to the Egyptian monarchy. He afterwards directed his march to the west, and his father lived to see the greater part of Libya conquered by his victorious son. When Sesostris mounted the throne, therefore, his military fame was established. The qualities of his mind, his dauntless courage, and his daring ambition, seemed to be announced by his personal appearance; and the people, no doubt, easily associated the character of the hero with the robust frame and gigantic stature[1] of their new monarch. But it is more material to state, that the success of his arms, in his wars with the Arabians and Libyans, had inspired him with the hopes of making yet more extensive conquests; and, if we may credit the Greek historians, the perilous project of subjugating the world must have been already familiar to the mind of Sesostris when he succeeded to the crown. Amidst the burning sands of Libya, and in the depth of the Arabian deserts, the phantom of universal empire showed itself, and he vowed to pursue it.[2]

His resolution being thus taken, no time appears to have been lost by the new sovereign in preparing his subjects for an enterprise, which could not be undertaken but in defiance of all the counsels of prudence. He caused various reports to be spread abroad, artfully attributing his project to other causes than his own ambition. His daughter Athyrtis, famed for her wisdom, as a sort of Egyptian Cassandra, proclaimed the facility with which her father would conquer the earth: the success of the enterprise was prognosticated by omens, by sortilege, and by divination: and the people were reminded that, at the birth of Sesostris, Phtha had appeared to his father in a dream, and had predicted to Amenophis that the new-born boy should one day become master of the world.[3] Nor did the Egyptian king content himself with influencing opinion in his favour by means of prophecies, prodigies, and visions. His natural sense taught him that other and more rational precautions were necessary; that a king who is not popular at home, should not think of making conquests abroad. His first object, therefore, was to secure the affections of the Egyptians: and for this purpose he employed all those arts which, exercised by sovereigns, are so powerful in conciliating popular favour. Some he won by his munificence, others by his clemency; the selfish were secured by his liberality, the vain were flattered by his condescension and affability; even traitors to the royal authority were allowed to escape with impunity, and public debtors were liberated from the prisons in which they were confined.[4] On the other hand, that he might provide for the tranquillity of his kingdom, and leave none behind him who either would or could attempt a revolution in his absence, he made a partition of power among the chief men of the nation, dividing the whole territory of Egypt into thirty-six nomes or prefectures, over which he appointed as many governors, each of whom was charged with the collection of the royal revenues, and the administration of the laws within his own particular district. He at the same time elevated his brother Armais to the rank of regent of the kingdom; and, except that this prince might not wear the royal diadem, he was permitted to assume all the pomp of a monarch; an indulgence which he so far abused as to usurp the crown in the king's absence, and to attempt his life on his return home from his long and perilous expedition.[5]

Having completed these and other necessary arrangements, Sesostris next proceeded to raise an army. The peace establishment of the kingdom, as previously organized by this prince, appears to have consisted of a numerous militia, divided into two classes, denominated *kalasires* and *harmatopoii*, and amounting, according to Herodotus, to 410,000 men, distributed throughout the different provinces as a species of military colonists, each man being allowed a portion of land adequate to the maintenance of himself and family. This formed the nucleus of the mighty force which Sesostris now raised for the conquest of the world, consisting, if we may believe Diodorus Siculus, of 600,000 infantry, 24,000 cavalry, and 27,000 war chariots; a force certainly equal to the magnitude of the enterprise in which he was about to engage, though it is difficult to conceive how the population of a small country like Egypt, supposing it ever so dense, could have supplied so vast a body of men, exceeding, by more than 200,000, the numerical strength of the army with which the Emperor Napoleon invaded Russia, and which was by far the largest ever assembled in modern times. No precise information has reached us as to the composition, organization, and discipline of this expeditionary army. We only learn, incidentally as it were, that the king chose as the leaders of his less experienced troops, the companions of his youth, trained, like himself, to the use of arms, and exceeding 1700 in number; that disgrace or infamy was attached to disobedience of orders and neglect of duty, and that meritorious or valorous deeds were liberally rewarded; circumstances which, taken in connection with the particulars above stated, seem to warrant the conclusion, that the military system of Egypt had reached no small degree of improvement, and that the science of war, in all its branches, had made considerable advances. With

[1] Sesostris was four cubits and four palms, or about seven feet in height, and seemed formed by nature to sustain all the toils and fatigues to which his active life was afterwards exposed. Diodorus, lib. i. sect. 55.

[2] Drummond's *Origines*, book iv. c. 13.

[3] Diodor. Sic. lib. i. sect. 53.

[4] Diodor. Sic. lib. i. sect. 54.

[5] Drummond's *Origines*, *loc. supr. cit.*

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a view to the ulterior objects of the expedition, Sesostris also collected or fitted out a fleet of 400 sail; and the ships are said to have been of large dimensions, adapted to the purposes both of war and transport.[1]

With these immense preparations the warlike monarch at length commenced his perilous enterprise. He invaded Ethiopia, and compelled the inhabitants to pay him a tribute in ebony, gold, and ivory. Even the ferocious Troglodytes yielded to the conqueror. Advancing farther to the southward, he passed the frontiers of Ethiopia, and entered the country extending beyond Sennaar to the Mountains of the Moon, where he left various monuments both of his power and of his piety. In the Straits of Dira or Babelmandeb he joined his fleet, consisting, as above stated, of 400 sail, which had already compelled the inhabitants of the islands in the Erythrean Sea, and of the adjacent continent, to acknowledge his authority. The victorious monarch next proceeded to India, which he completely overran, extending his conquests beyond the Ganges, and subduing some of the countries which lie between that river and the Eastern Ocean. He then directed his course towards the country of the five rivers or Punjab; crossed the immense reticulation of streams, which ultimately unite their waters with the Indus; and ascended the table-land of central Asia. Nor were the Scythian nations able to resist the torrent as it rolled westward through Tartary, behind the mountains of Imaus, and north of the Caspian, to the river Tanais and the Palus Mœotis. Having entered Europe, Sesostris passed through Sarmatia, Dacia, and Mœsia, nor halted until he arrived in Thrace, where he erected columns to perpetuate the memory of his victories, and to prove the extent of his conquests. From Thrace he crossed over into Asia Minor, and advanced into the plains of Colchis (rendered so famous in Grecian story by the expedition of the Argonauts and the fable of the golden fleece), where he founded a colony on the banks of the Phasis, and erected monuments, some of which were in existence in the age of Herodotus. He then marched against the Assyrian empire, which he conquered, and thus seated himself on the throne which had been occupied by Ninus and Semiramis. Finally, surrounded with the trophies of victory, and enriched with the spoils of nations, Sesostris returned to Egypt in triumph, after having been thirty years engaged in an expedition, undertaken in defiance of all the dictates of prudence, yet, if we believe the concurrent testimony of historians, terminated without a single reverse of fortune.[2] Such is the military story of the renowned Rhamses.[3] That it involves many improbabilities is obvious; but what portion of ancient history is free of them? Mankind, in every age of the world, have taken delight in the marvellous; and if the ancients appear to have been pleased with reading romances in history, the moderns seem equally disposed to read history in romances. The great difficulty in forming an accurate judgment as to the story of the Egyptian monarch arises from the total want of details. We hear nothing of the generals to whom he was opposed, of the cities which he besieged, nor even of the battles which he fought. Historians relate his triumphs, but are silent respecting the skill which obtained them. At the same time, it cannot reasonably be doubted, we think, that there is a large substratum of truth in the narratives which have reached us respecting this extraordinary personage. By the concurrent testimony of the ancient authors, confirmed by the evidence derived from the Egyptian monuments, he is represented as a great warrior and conqueror; as the first, and, we may almost add, the last, of the Pharaohs who pursued the phantom of military renown, and sought for glory in distant expeditions: nor are there wanting circumstances which warrant the conclusion, that he overran some countries, conquered others, and left traces of his progress in many parts both of Asia and Europe. That he established a regular army, and provided a fleet to co-operate with it in his expedition against the countries of the East, are facts which seem to be as well attested as any in ancient history.[4]

Persian armies.

" C'est chez les peuples d'Asie, chez les Perses surtout," says Guibert, " que l'art de la guerre commença à prendre quelque consistance;" but he adds, " après la mort de Cyrus, le luxe lui fit quitter la Perse, et il passa chez les Grecs."[5] This remark, however, must be taken with some important qualifications. As a general proposition, it is doubtless true that the military art first assumed consistence among the Asiatic nations, particularly the Persians; for the warlike spirit of Egypt seems to have expired with its first and only conqueror. But it is utterly absurd to maintain that the death of Cyrus was productive of any change in the military system of Persia, or that this event led to the transference which Guibert has so gratuitously supposed. Cyrus, in as far as we are able to distinguish his character, and form a judgment

[1] *Origines, ubi supra.*

[2] Diodorus, lib. i. sect. 54 and 55; Strabo, lib. xvi.; Herodotus, lib. ii. c. 103 and 110; Manetho *apud Joseph. contr. Apion.*; Julius Africanus *apud Syncellum.* In all the countries through which he passed, Sesostris left monuments behind him; and where he encountered serious resistance, the columns he erected bore this inscription: " Sesoosis, King of Kings, and Lord of Lords, has subdued this region by force of arms." Diodorus, *ibid.*

[3] The information given to Germanicus when he visited the ruins of Thebes, by some of the elder Egyptian priests, relative to this monarch, and the military establishment he had created, is thus recorded by Tacitus in the second book of his Annals: " Mox (Germanicus) visit veterum Thebarum magna vestigia; et manebant structis molibus litteræ Ægyptiæ, priorem opulentiam complexæ; jussusque e senioribus sacerdotum patrium sermonem interpretari referebat habitâsse quondam *septingenta millia* ætati militari: atque eo cum exercitu regem RHAMSEN Libya, Æthiopia, Medisque et Persis, Bactriano ac Scytha potitum; quasque terras Suri Armeniique et contigui Cappadoces colunt, inde Bithynum, hinc Lycium ad mare imperio tenuisse," &c. The strength of the army of Sesostris, as here stated, very nearly coincides with the amount given in the text, on the authority of Diodorus. According to the latter, this army consisted of 600,000 infantry, 24,000 horse, and 27,000 armed chariots; which, as at least *three* men fought in *one* chariot, would make a total of 695,000 men, or only 5000 less than the number reported by the priests to Germanicus on the faith of the monuments.

[4] *Origines, ubi supra.* " It would be in vain," says Sir William Drummond, " to deny to the traditions of ages, to the records of history, and to the authority of monuments, that Sesostris must have been one of the greatest princes that ever lived; while we may fairly confess our doubts of the extent of his conquests, and acknowledge that we cannot ascertain at what period he flourished. The existence of the monarch we may consider as certain; and some of the achievements of the conqueror we may admit to be probable, though we cannot fail to perceive, that the number of his triumphs has been amplified by exaggeration, and the history of his reign crowded with fictions. It is known that the great Ramesses or Ramestes created at least one obelisk, on which he announced himself to be loved and gifted by all the gods of Egypt; but it may be questioned whether he had a right to call himself the master of the whole habitable world. We may believe that Sesostris obtained many victories, and subdued many regions; while we may still avow that we are unable to tell when this mighty monarch reigned, where were the limits of his empire, what humbled nations bowed down before his throne, or what captive kings were yoked to his triumphal car."

[5] *Essai Général de Tactique*, vol. i. p. 61.

of his achievements, appears to have been a wise prince, a warlike monarch, and a great conqueror;[1] while the victories achieved by the Persians under his command, contrasted with the fatal reverses which they afterwards experienced, may induce superficial observers to imagine that the knowledge of the art declined after the hero's death. No opinion, however, can possibly be more erroneous; except, indeed, it be that which represents the Greek tactics as having been primarily derived from the Persian, to which, as will appear in the sequel, they bore not the slightest resemblance. The qualities of the Persian troops may, perhaps, have deteriorated, and, under the influence of luxury and refinement, the military character of the nation may have declined; but the system of organising armies and making war continued, in a great measure, unchanged: nor, as far as the military art is concerned, would it be easy to discover any material difference between the tactics of Cyrus, who was uniformly victorious, and those of Xerxes, Mardonius, and Darius, who experienced the most disastrous defeats. It should also be remembered, that the former led Asiatics against Asiatics, and that the nations he subdued were among the most effeminate and voluptuous of the ancient world: whilst the latter were called to contend with the Greeks in their best days, when their bodies were robust, their hearts strong, and their discipline admirable; and when their armies were commanded by men fired alike with the love of liberty and of glory, and not only conversant with the science of war, theoretically considered, but eminently skilful in all those resources which neutralize superiority of numbers, and enable handfuls of men to snatch the victory from masses apparently overwhelming and invincible.

The strength of the Persian army consisted in its cavalry, which was always of excellent quality, and capable of achieving great things had it been properly commanded. This was emphatically evinced at the passage of the Granicus, where its gallant conduct attracted the admiration of every officer in the Macedonian army, from the king to the humblest dilochite in the ranks.[2] Notwithstanding the absurd principle upon which it was formed, and the total want of support, owing to the treachery or terror of the Greeks in the pay of Darius, who had been brought forward to sustain it, this cavalry bravely disputed the passage; drove Ptolemy, who commanded the vanguard of the Macedonian army, back into the river; charged the heads of the columns as they successively ascended the bank in order to deploy, with the utmost impetuosity; and maintained the combat until it was attacked by the formidable phalanx in front, and by the light infantry on both flanks, when it was at length forced to retire.[3] The Persian infantry had none of the qualities for which the cavalry was distinguished, and seems, in fact, to have been little better than a military mob, without coherence or solidity; while the vast numbers of this arm which were commonly brought into the field impeded the action of the cavalry, which they were incapable of supporting, and served only to create confusion, and supply food for the slaughter, when opposed to disciplined armies commanded by men conversant with military combinations. Marathon, Platæa, and Mycale, all bear witness to the truth of this observation. The war-chariots formed another source of disorder and weakness. Their number, like that of the infantry, was excessive; and as these vehicles could only act upon level ground, they were altogether useless and unavailing in a broken country, or against a skilful commander. With regard to the numerical strength of the Persian armies, we have no precise information, and can only form a conjecture from the statements, almost always exaggerated, of the Greek historians as to the numbers actually brought into the field. Xerxes, who had taken by descent a hereditary hatred of the Greeks, invaded Europe, it is said, and entered Greece at the head of an army, which, with its retinue of servants, eunuchs, and women, amounted to upwards of 5,000,000 of souls; a statement which, if true, would imply that the Persian nation had risen *en masse* to overrun the countries of the West. Yet this vast multitude, or rather horde, was arrested in its progress by 300 Spartans at the pass of Thermopylæ; and that mountain gorge would have become the scene of its total defeat and destruction, had not a base Trachinian betrayed this devoted band of heroes, and enabled the Persians to attack it at once in the front, the flank, and the rear. At Marathon, Datis and Artaphernes, lieutenants of the Great King, brought into the field 100,000 foot and 10,000 horse,[4] which were beaten by 10,000 Athenian infantry and 1000 Platæan auxiliaries, commanded by Miltiades. At Platæa, the Persian force, consisting in all of 300,000 men, was again defeated with great loss by a handful of Lacedæmonians and Athenians under Pausanias. And at the battle of Mycale, fought on the same day with that of Platæa (22d September 479 B. C.), 100,000 men, the wrecks of that portion of the army more immediately under the command of Xerxes, which had just returned from the unsuccessful expedition to Greece, were completely overthrown and dispersed by a small body of Greeks, who stormed their entrenched camp, slaughtered several thousands, and carried off an immense booty. On comparing these various numbers, and making due allowance for casualties, it would appear that the Persian monarch must have entered Greece with about 600,000 fighting men; an enormous force numerically considered, but not too great to provoke incredulity, when we reflect on the mode in which the eastern nations have always made war, and further take into account the circumstance, that nearly the whole of one reign and part of another were consumed in making preparations for this ill-fated expedition.

Of the state of the Persian army in the reign of Alexander, Arrian has furnished us with many important particulars, especially in his account of the battle of Arbela, which is the more interesting, as it gives us some insight respecting the Persian tactics under the last Darius. According to this writer, who had consulted the memoirs of Ptolemy, one of Alexander's generals, but who, nevertheless, seems to have possessed the Greek talent for exaggerating numbers, the army which Darius brought into

[1] The achievements of Cyrus, like those of Sesostris, have been so exaggerated by historians, and embellished by fabulists, that almost every grain of truth has to be separated from a bushel of fiction. The Cyropædia is merely a philosophical romance, with no more of truth or fact in it than is sufficient to give verisimilitude to the story.

[2] The Persian cavalry, 30,000 strong, was, on this occasion, commanded by Memnon, who drew it up in a single line of equal extent with that occupied by the Macedonian army on the other bank of the river. The ground on which it was posted sloped gradually towards the bank of the Granicus, which was here steep and difficult, and hence no position could have been chosen more favourable for the effective action of such a force. But its energies were paralysed, or, which comes nearly to the same thing, its full capabilities were never brought into play, in consequence of its linear formation, which admitted only of detached efforts, without *ensemble* or support. (Guischardt, *Mémoires Militaires sur les Grecs et les Romains*, tom. i. p. 251–258. Lyons, 1760.)

[3] Guischardt, *ubi supra*.

[4] The total number of Persians engaged at Marathon was, according to Valerius Maximus (l. v. c. 4), 300,000; according to Justin (l. ii. c. 9), double this amount, or 600,000 men. No attention whatever is due to such extravagant exaggerations.

Army.

the field on this occasion consisted of 1,000,000 infantry, 40,000 cavalry, 200 chariots armed with scythes, and 15 elephants; a statement which appears equally incredible, whether we regard the absolute amount here assigned, or attend to the glaring disproportion between the relative numerical strength of the different arms. Quintus Curtius, who reduces the infantry to 600,000, and raises the cavalry to 145,000, exaggerates at least with method, and thus avoids an objection fatal to the numerical accuracy of the military historian. The disposition of this enormous force, as described by Arrian, shows the incongruous elements of which it was composed. According to the custom of the Persians, the king placed himself in the centre, having around him his relations and the officers of his court, with his ordinary guards, foot and horse, which sometimes amounted to 15,000 men. These he supported by a body of Greeks in his pay, upon whom he placed great reliance, and by other *corps d'élite* furnished by the native army. The Persians, the Susians, and the Candusians composed the left; on the right were the Syrians, the Assyrians, and other nations, subjects or allies of Persia; and the whole was formed into squares or masses of prodigious depth, evidently with the intention of resisting the compact formation of the Macedonian phalanx, of which the Persians had already had woeful experience. These different nations were variously armed, some with missile weapons, others with pikes, hatchets, maces, &c.; and cavalry were stationed in the intervals between the squares. The reserve was composed of those for whom no place could be found in the first line; and being drawn up too close to it, served only to augment the confusion. The infantry of the left was flanked by the main body of the Persian cavalry, and part of that of the Bactrians; together with two corps, one Scythian and the other Bactrian, a little in advance. On the right, the Armenian and the Cappadocian cavalry were posted in a similar manner, though not in equal force. Two hundred armed chariots were drawn up before the left, and fifty before the right of the infantry, while the elephants and fifty more chariots were placed in advance of the centre.[1] Such was the disposition of the army of Darius on this memorable and decisive day. It was doubtless bad in many respects, particularly in the disproportionate crowding of all arms on the centre and left, while the right was left comparatively weak and uncovered; but its greatest defect, inseparable, perhaps, from the heterogeneous composition of the army, consisted in this, that the defeat of any one part of the line was certain to throw the whole into irretrievable disorder, and to end in a complete rout. Still it showed very considerable knowledge of the military art; while the battle which followed, and which was bravely contested, is even yet considered a study for tacticians.

The Greek armies.

From the earliest times, the genius of the Greeks, adventurous and free, inclined them to war. This, at first a consequence of their position, became in time an attribute of the national character, and gave rise to institutions which, in their turn, served to diffuse and confirm the spirit in which they had originated. Divided into a number of petty states, which were separated often by imaginary boundaries, and naturally jealous of one another, Greece was a scene of never-ending contention, and the theatre of almost continual war. New causes of difference, in the shape of injuries, encroachments, or insults, real or imaginary, were incessantly arising; and as each state was alike proud of itself, suspicious of its neighbours or rivals, and, above all, watchful of its independence, the wrong done, or believed to have been done, was promptly followed by retaliation, which again provoked a repetition of the offence, and thus led ultimately to war. Such a state of things naturally fostered a warlike spirit, and gave birth to military institutions; while the necessity of self-defence, still more than the love of conquest or of glory, rendered it imperative that every citizen capable of bearing arms should be ready to appear in the field at the call of his country. But experience soon taught the important lesson that numbers did not constitute strength, and that a small body of men prepared by early training for the duties of war, and subjected to a system of regular discipline, were capable of contending, on equal terms, with great numerical odds. When this discovery was first made, we have no means of ascertaining precisely; but it is one which must early have occurred to the rulers and governors of small states like those of Greece, the scanty population of which imposed upon them the necessity of devising the best means for rendering its disposable strength effective and available. Hence we find, that one great object of the early statesmen and legislators of this country was to organize a system of physical and moral education adapted to its peculiar position and circumstances; to engraft the military spirit on those institutions which were destined to form the general character of their countrymen; and, amidst the pursuits of peace, to prepare the minds and bodies of their citizens for encountering the fatigues, privations, and perils of war. Nor did their labours prove fruitless or vain; for the institutions thus prepared being suited alike to the genius and condition of the people, soon struck their roots, as it were, into the soil, and ere long produced those fruits which have for ages been the wonder and admiration of mankind. But less perhaps of this wonder and admiration is due to the bravery of the Greeks, eminent as it always was, than to their discipline, organization, and conduct in the field. Among them all the branches of the military art were simultaneously cultivated, and received the most important improvements. Their formation was rendered compact and formidable; combining solidity and the power of resistance, with a mobility which made these qualities available on different points, even in action. Their tactics were singularly adapted to the peculiar character of their troops, and were founded on the most certain principles of the art.[2] And, in later times, we find strategy recognised and taught as a science in the schools;[3] while, in the field, it received, in several respects, a development which no other nation, ancient or modern, has yet been able to surpass. Lastly, we may observe, that until the reign of Philip, the father of Alexander the Great, Greece had no standing army. Her strength consisted in her militia; and to this description of force she was indebted for the imperishable glories of Marathon, Platæa, and Mycale, when the myriads of the Persian invader were successively overthrown. But, from the causes above indicated, and the incessant contests in which the different states were engaged with each other, this militia had acquired the principal characteristics of a regular force, both as regards

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[1] Guischardt, *Mémoires Militaires sur les Grecs et les Romains*, tom. i. p. 260–61.

[2] Guibert, in his *Discours Préliminaire*, part second, underrates the tactics of the Greeks. "Je compare les guerres des Grecs," says he, "et la plupart des guerres des anciens, à celles de nos colonies dans l'autre continent. J'y vois cinq ou six mille hommes les uns contre les autres, des champs de bataille étroits, où l'œil du général peut tout embrasser, tout diriger, tout reparer. *Un bon major conduiroit aujourd'hui la manœuvre de Leuctre et de Mantinée, comme Epaminondas*," p. 82. It will be fortunate for modern armies when their "good majors" are as skilful and as brave as Epaminondas.

[3] Guischardt *Mémoires Militaires*, tom. ii. p. 155.

organization and discipline, and consequently was of nearly equal avail against an enemy in the field.

The Spartan army.

To the institutions of Lycurgus Sparta was indebted for her military pre-eminence among the states of Greece. To exclude all refinement and luxury, to cultivate the sterner virtues of abstinence and self-denial, to inure the body to hardships and the mind to suffering, to inculcate self-sacrificing patriotism, and to form great characters, appear to have been the principal objects of this iron-hearted legislator; who accordingly laid the foundations of his institutions in a system of primary education, intended and calculated to convert the free male population of the state into a military community, and to develope to the utmost all those physical and moral qualities which render men invincible in war. Nor did the results disappoint the calculations upon which this system had been founded. Trained from their earliest years to suffer the extremes of heat and cold, hunger and thirst, to endure pain with unflinching fortitude, and to despise danger and death; habituated to the most implicit and unquestioning obedience to all placed in authority over them; and continually exercised in running, wrestling, swimming, ball-playing, and martial games of all sorts, as well as in stratagems, surprises, and ambuscades; the Spartan youth, when called to take the field, were prepared at once to enter upon the duties of war with alacrity and vigour, and to regard with indifference all the privations and fatigues of the severest campaign. Nor were their discipline and organization inferior to their military qualities. The Spartan phalanx, which formed the basis of the Macedonian, consisted of eight files in depth.[1] The files were placed at intervals of six feet from one another when disposed in open order; in close order the distance was three feet; in locked order one foot and a half; the intervals being thus diminished one-half at each approximation. The open order was that observed on the march, and in evolutions or manœuvres; the close order was for the attack; and the locked order was that in which an attack was received. The front rank consisted of picked men; the rear rank was also select; while those upon whom least dependence could be placed had their station in the centre, in order to give impetus and momentum to the column by their weight and physical power. The different parts of the phalanx were classed according to a regular system, and, in particular, the covering file was matched in quality as nearly as possible with the file in front; so that if the whole or any part of the front rank failed, the vacancies were supplied by the second files, without disordering the line. The arms, offensive and defensive, of the soldier, consisted of a spear or pike, a short sword or dagger, and a shield or buckler of an oval form, which was fastened round the neck and at the left shoulder by means of straps. But latterly Cleomenes changed this clumsy encumbrance for the Macedonian shield, originally invented by the Carians, which was fastened on the left arm by a ring or belt, so as to leave the soldier free to employ both hands in giving force and direction to the pike. The Spartans were also familiar with the most approved evolutions, which they performed with equal celerity and precision. The rear of the phalanx became the front, or the front the rear, by the shortest and simplest operation; while, by redoubling its formation, it became a solid square, bristling on every side with pikes, and, in locked order, wholly impenetrable to attack, except upon broken ground. Rapid changes of front even in the presence of an enemy, refusing or advancing a wing at a critical moment, turning an enemy's flank, and many other manœuvres, which are still considered equally delicate and difficult, were frequently executed with the most complete success by the commanders of these formidable columns. In a word, the Spartans may be regarded as the founders and first improvers of that military system, which attained its perfection under Alexander, and placed the crowns of Asia at his feet.[2]

The Athenian army.

The Athenian military force consisted of three classes; first, the heavy troops, ὁπλῖται, armed with a spear, a dagger, a cuirass or corslet, and an oval shield, and reserved for the phalanx or main battle; secondly, the light troops, πελτασταί, armed with a light spear, a javelin, and a target, and destined for skirmishing, seizing or maintaining positions, and covering the movements of the phalanx; thirdly, irregular troops, γυμνῆται, without defensive armour, but provided with missile weapons, such as javelins, bows and arrows, and slings, for harassing an enemy on his march, or performing the duties of light troops in the field.[3] The phalanx or main battle consisted entirely

[1] There is some confusion among the ancient writers on the subject of the division of the Spartan force. Thucydides, describing the arrangement and proportions of the Spartan army at Mantineia, informs us that a battalion or *lochos* consisted of four *pentecosties* or companies, a pentecostie of four *enomoties* or platoons, and each *enomotie* of 32 men; thus making the whole strength of the battalion 512 men. But he makes no mention of the number of battalions in a regiment, and indeed acknowledges that the subject was obscure, and his information imperfect. According to Xenophon, the Spartan *mora* or regiment consisted of four *lochi*, the lochos of two *pentecosties*, and the pentecostie of two *enomoties*. The number included in the last denomination is not given; but, if we assume that it consisted of 32 men, as stated by the historian first named, the regiment of Xenophon would amount to 572 men, or 50 more than the battalion of Thucydides. How are these discrepancies to be reconciled? It is scarcely probable that the division of the Spartan force underwent any change in the interval between the time of Thucydides and that of Xenophon; but it is very probable that neither may be correct, considering that the Spartans studiously concealed from the observation of foreigners the internal organization and strength of their armies.

[2] The Spartan phalanx advanced to meet the enemy's at a regular step, in accord with the cadence of military music, and, even when beaten, generally retired from the field in perfect order, however reduced in number. After battle, every soldier was obliged to produce his shield, as a proof that he had fought, or retired, as a soldier ought to do, bravely and steadily. If he had lost or thrown away his shield he was disgraced for ever; the brand of indelible infamy was fixed upon him. But this was of rare occurrence; for the love of military glory was the only passion which the Spartan people were allowed to cherish; and both education and discipline had combined to eradicate fear from their bosoms. It was a word unknown in their vocabulary. In this singular country all passions merged in one. The Spartan mother and the Spartan wife rejoiced when a son or a husband had fallen honourably in the field of battle, and sometimes refused to recognise as of kindred with themselves such of their relatives as had survived a defeat. The only mourners on account of the disaster at Leuctra were those whose friends and kinsmen had escaped the slaughter of that bloody day.

[3] These classes may be considered as analogous, the first to the grenadiers, the second to the light infantry, and the third to the riflemen or sharpshooters of modern armies. Their armour, however, was different at different times; for the Greeks, like the Romans, made several changes in this respect; and hence the apparent discrepancies which we meet with in the accounts of historians. For example, when Arrian mentions the militia of the ancient Greeks, he speaks of the times which preceded the constitution and organization which Philip and Alexander the Great gave to their troops. The oval buckler, larger than common, and the long pike or *sarissa*, were introduced by these sovereigns, and found to add incalculably both to the defensive and offensive power of the phalanx. Some of the Greeks, however, piqued themselves on not adopting the changes of Alexander; but Philopœmen at length persuaded the Achæans to lay aside their ancient arms, and assume those of the Macedonians.

of natives of Attica, and was drawn up according to tribes or communities, probably with the view of exciting a generous rivalry in deeds of arms. The light armed troops were partly native and partly foreign; the slingers and archers were wholly foreign. The cavalry, like the heavy-armed infantry, consisted of natives alone, and were of a good description, being remarkably alert, intelligent, and enterprising. Thus composed, the Athenian army was prepared for every species of warfare, and equal to the most arduous achievements. The intelligence, activity, quick perception, and daring spirit of enterprise for which the native of Attica, the Frenchman of Greece, was distinguished, rendered him formidable in desultory warfare, alert in his movements, and prompt in taking advantage of every favourable circumstance; insomuch that the Athenian light troops foiled, and on some occasions even discomfited, the renowned Spartan phalanx. The Athenian phalanx was less compact than that of Sparta, and, owing to the character of the people, as much perhaps as to its formation, less adapted to receive and repel an attack; but in the charge it was perfectly irresistible. Its onset was terrible, and overthrew all before it. The cause of this must be sought in the difference of national character. The Spartan was chiefly celebrated for his passive, the Athenian for his active courage. Hence the one was powerful in resistance; the other formidable in attack. The Spartan was steady, devoted, and firm; the Athenian bold, enterprising, intelligent, and full of address and dexterity. If the one was less capable of resistance, the other was more ardent and impetuous; their military qualities were as opposite as their natural characters, but both were admirable of their kind; and if it had been possible to combine them together in equal proportions, perfect soldiers might have been formed, and a perfect army organized. The Athenians, we may observe, were the first of the Greeks who advanced upon the enemy at an accelerated pace corresponding to what is now called double-quick time. This innovation was first introduced by Miltiades at Marathon, in order to give increased momentum to the charge which he directed against the Persian masses; and it was consecrated in Athenian tactics by the glorious result of that ever-memorable day.[1]

The Macedonian army.

But the very principles which had saved the states of Greece from foreign invasion, and enabled them to maintain their independence, were destined to form the basis of a military establishment, more formidable, because more complete in all its parts, than any which that or other countries had yet produced, and organized for the express purpose of serving as an instrument for subverting Grecian liberty. We allude of course to the Macedonian army in the reigns of Philip and his son Alexander the Great. The founder of this establishment, Philip of Macedon, was a man of unquestionable talents, of convenient principles, and of boundless ambition. Having improved his natural parts by associating with the scholars, statesmen, and philosophers of his age; and having been initiated into the scientific principles of the art of war under Epaminondas, the most celebrated master of the time; he was early fired with a love of military glory, and a lust of conquest and dominion. But although the brilliant period in the annals of the Greek states was past when Philip made his appearance, and these communities had already begun to show symptoms of decline, enough of the ancient spirit still remained to convince him, that, without creating new means, and organizing a force different from any which had yet existed, he could never hope to realise his ambitious projects, by rendering himself the master of Greece. The sagacity of Philip was fully on a level with his ambition. He saw that in the rude shepherds and hunters of Macedonia might be found the raw material of an army; that discipline and organization were alone wanting to convert this material into an invincible force; and that to render a military force completely effective, or, in other words, to derive from it the utmost benefit it was capable of affording, it was indispensably necessary to depart from the militia system which had hitherto prevailed, and to start from the principle that no army could be good which was not permanent. He was thus the first who fully comprehended the importance of a standing army, both as regards the efficiency of a military body itself, and also with reference to projects of conquest or ambition; and he may further claim the distinction of having been the first to organize a permanent force. In prosecuting this design he showed a skill, and a knowledge of the principles of military organization, equal to the sagacity evinced by its conception. Adopting the Spartan phalanx as the basis of his system, he gave it greater depth and solidity, so as to render it irresistible in the attack, and impenetrable when drawn up in position. He changed or improved its armour both for offence and defence; and, in particular, introduced the large oblong buckler, and the *sarissa* or Macedonian pike, the most formidable weapon of ancient times. The light-armed troops were also placed on a better footing than they had ever before been among the Greeks, being formed in demi-phalanges, which, without materially lessening their mobility, rendered them capable of combining their efforts in an effective manner with those of the heavy-armed infantry. The equipments, arms, and discipline of his cavalry were in like manner improved, and their organization perfected, with the utmost care and diligence. In a word, all that was excellent in the different Greek systems was combined in the Macedonian; while their defects were avoided, and improvements introduced wherever these seemed to be either expedient or necessary. Such was the general character of the military establishment which Philip created for enabling him to trample on the liberties of Greece, and which Alexander employed in subjugating the world. We shall now speak of its different parts in detail.

The phalanx was composed of files of a certain depth, and of regular combinations of those files. The *lochos* or file was a number of soldiers ranged in line, one behind the other, from the head to the *serre-file* or *ouragos*. The file consisted at different times of different numbers of men, as eight, ten, twelve, and sixteen. Alexander chose the last, because it formed the best proportion relative to the extent and depth of the phalanx; nor did it prevent the archers and slingers, stationed behind, from launching their missiles at the enemy, over the heads of the phalangites. If the phalanx was doubled to form a solid column, or reduced to one half in order to extend its front, the respective depths of 32 and 8 still remained proportional; but if the original depth of the file had been only 8, as in the Spartan phalanx, the latter evolu-

[1] It is very much to be regretted that no military or scientific description has been preserved of the battle of Marathon. The accounts which have reached us, being written by men ignorant of military affairs, are meagre, confused, and unsatisfactory; containing details, indeed, of the numbers engaged, and the amount of the slain, but giving little or no information respecting the combinations and manœuvres which decided the fortune of the day. One thing only is certain,—the victory was the result of consummate generalship on the part of the commander, and of heroic valour on that of the soldier.

tion could not have been performed with safety, because it would have reduced the depth to 4, and thus deprived the formation of its peculiar characteristic of solidity. The preference given to the number 16, therefore, was on account of its divisibility, and its admitting of evolutions consistently with the nature of the phalanx, which could not have been attempted with files composed of any other number, greater or less. The best man was chosen as the head of the file, and named *lochagos* or *protostate;* the second was called *epistate;* the third bore the same name as the first, the fourth the same as the second, and so on to the last; so that each file was composed of *protostates* and *epistates*, ranged alternately from the *lochagos* to the *ouragos*, who was also a picked man.[1] The junction of two or more files was denominated *syllochism*. It was effected by placing the *protostates* and *epistates* of the one exactly opposite the *protostates* and *epistates* of the other; and one man, considered in reference to his juxtaposition with another, was called *parastate*. The junction of all the files formed the phalanx; of which, therefore, the *lochagi*, or heads of files, constituted the front rank, and the remaining *parastates* in alignement, as far as the *ouragi* or *serre-files*, the depth.

The phalanx, thus composed, was divided into two equal parts; one called the right wing or head, and the other the left wing or rear. The point of separation or division was variously denominated the navel, the mouth, and the jointure of the phalanx. And as the principle of this formation was, that every combination should be divisible into two equal parts, so the phalanx, as finally constituted by Alexander, was composed of 16,384 heavy-armed men, the half of which number was considered sufficient for light troops, and the half of that again, or the fourth of 16,384, sufficient for cavalry; while the divisibility into equal parts afforded great facility for executing with precision all manner of evolutions, and extending or diminishing at pleasure the front of an army. The total number of the phalanx being, as already stated, 16,384, and each file consisting of 16 men, it follows that there were in all 1024 files. But each combination of files had its peculiar and appropriate denomination. Two files united formed a *dilochie*, under a *dilochite;* four files, a *tetrarchie*, under a *tetrarch;* two tetrarchies, a *taxiarchie*, under a *taxiarch* or *centurion;* two taxiarchies, a *syntagma* or *xenagie*, under a *syntagmatarch* or *xenagos;*[2] two syntagmata, a *pentecosiarchie*, under a *pentecosiarch;*[3] two pentecosiarchies, a *chiliarchie;* two chiliarchies, a *merarchie* or *telarchie;* and two merarchies, a *phalanx* of 4096 men in 256 files, which was commanded by a general, under the name of *phalangarch*. Again, two phalanges formed a *diphalangarchie;* and two diphalangarchies, a *tetraphalangarchie*, or the grand phalanx, which thus consisted of two wings or diphalangarchies, four phalanges, eight merarchies, 16 chiliarchies, 32 pentecosiarchies, 64 syntagmata, 128 taxiarchies, 256 tetrarchies, 512 dilochies, 1024 files, and 16,384 men. The front might be extended by simply augmenting the distance between the files; the phalanx was closed by lessening the distances between the ranks and the files, and thus diminishing both its front and its depth. Its locked order was called *synapism*, in which the ranks and files were so closely approximated, that the soldier could not turn.[4] In this formation the men at the exterior of the mass held their bucklers before them; the next rank raised their bucklers over the heads of those immediately in front of them; the third rank held their bucklers over the heads of the second, and so on; thus forming a sort of roof, over which the archers in the rear sometimes passed to the front, and which, from the bucklers being joined like the scales of a crocodile, resisted and threw off the heaviest missiles discharged by the enemy. As every thing depended on the steadiness of the heads of files and their *epistates* of the second rank, both were *gens d'élite* or picked men. When the phalanx was closed for action, each man occupied only three feet of ground in rank and file. The pikes or *sarissæ* were 24 feet in length, 6 feet being behind and 18 feet before the grasp; consequently (as the ranks were three feet separate), the second rank advanced the pike 15 feet, the third 12, the fourth 9, the fifth 6, and the sixth 3 feet; thus presenting an array of points such as never bristled along the front of any other military mass or column. The soldiers of the other ranks, as they could not employ their pikes, pushed on those before them, and, by their weight, served to augment the violence of the shock.[5] In this case every thing depended on the *serre-files* or *ouragi*, who were the keys of the phalanx, and, like the *lochagi*, picked men. Such was the Macedonian phalanx,[6] which was destined to conquer the world, and to be, in its turn, conquered by the world's conquerors. It yielded to superior tactics and greater mobility.

The light-armed infantry were drawn up in different ways, according to the nature of the ground and the dis-

[1] Some authors designate a file *stichos*, others *decuria*. They who apply the latter epithet seem to suppose that it consisted of ten men, which is not true as respects the Macedonian file. We have followed, in the text, the nomenclature of Arrian, whose authority on this subject is decisive. With regard to the term *enomotie*, which has so much puzzled commentators, we have already shown that it means something different from a file, or part of a file. It was a term peculiar to the military system of Sparta, whence it passed into the other systems of Greece, including the Macedonian; but no data have been given from which its precise import can be ascertained.

[2] The *syntagma* or *xenagie* had four supernumerary men; a standard-bearer, an officer who marched behind and performed the duty of our major, an adjutant, and a crier to repeat the orders. This section, ranged in order of battle, formed a perfect square. (Arrian's *Tactics*.)

[3] The *pentecosiarchie* of the Macedonians answered to the *lochos* of the Spartans. This must be kept in mind in the perusal of Thucydides and Xenophon, otherwise both will be unintelligible.

[4] It was to this locked order that Epaminondas was indebted for the victories which he gained over the Lacedæmonians at Leuctra and at Mantineia. The Theban army was formed in columns of attack, upon a front considerably less than the depth. The shock, therefore, proved too much for the Spartan phalanx, which was only eight deep. Xenophon compares it to that of a heavy vessel striking a light one amidships with her bow, and dashing her to pieces by the collision.

[5] The loss of men in the day of battle, or the necessity of sending out detachments, made no change in the form and disposition of the phalanx. The sections were always kept up to their full complement of ranks and files. The effective diminution fell, not upon the ranks and files, but upon the number of the sections, which were retrenched in proportion as they filled up the void in the phalanx.

[6] The Macedonian phalanx, says Arrian, was as formidable in appearance as it was in reality; and Paulus Æmilius confesses, that, when he saw, for the first time, this imposing mass, with its front bristling with the terrible *sarissæ*, he was struck with consternation. Guischardt alleges that it was "plus terrible à l'aspect que dans l'effet;" and adds that Paulus "ne laissa pas que de la battre avec ses Romains épars et distribués en plusieurs pelotons." But if Alexander had commanded it, the Roman would have told a different tale. Guischardt has himself demonstrated that the loss of the battle of Cynocephale was mainly, if not exclusively, owing to the stupidity of Philip in committing the phalanx upon broken ground, where its flanks were uncovered, and the principal advantages of its formation lost.

position of the enemy; sometimes before the phalanx, sometimes behind it, sometimes on both wings, sometimes only on one. Their formation was in all respects similar to that of the phalanx, and their files, eight deep, were combined upon analogous principles. The Macedonian cavalry was of various descriptions, as *kataphracti*, light horse, and *acrobolistæ*. The *kataphracti* or cuirassiers were completely covered with defensive armour; the man with a cuirass and cuisses of iron scales, the horse with a frontlet and mail. Their offensive arm was the Macedonian pike. The light cavalry, unencumbered with heavy armour, carried lances and missile weapons. The *acrobolistæ* had no lances, and, like the Armenian or Turkish cavalry, used only the bow and arrow. They were a species of Cossacks or irregular horse, and performed the duties of such. The usual formation of the regular cavalry for attack was the cuneiform, which had been introduced by Philip, from an idea that it was the order best calculated to pierce an enemy's line; but they were sometimes drawn up in squares, sometimes in the form of a rhombus, and sometimes also in a line.

The numerical strength of the Macedonian, like that of other ancient armies, can only be conjectured from the numbers actually brought into the field. In the time of Philip it probably never exceeded a grand phalanx, with its proportional complements of light troops and cavalry, 28,603 in all, and a few thousands of auxiliary troops. At the passage of the Granicus, Alexander's army consisted of above 30,000 infantry and 5000 cavalry; from which we may conclude that it was composed of one grand phalanx, with its proportional complements of light troops and cavalry, and about 6000 auxiliaries. But it was afterwards powerfully reinforced; for Alexander paid great attention to recruiting, especially in Greece, and had always generals detached from the army for the purpose of raising new levies in that country. Accordingly we find that, at the battle of Arbela, the Macedonian army consisted of two grand phalanges, or 32,768 heavy armed infantry, two corps of *peltastæ*,[1] each 8186 strong, and 4096 cavalry, including the Thessalian horse, besides several thousand auxiliaries, chiefly irregular troops; thus making a grand total, including auxiliaries, of at least 60,000 fighting men, or 54,000 regular and 6000 irregular troops.

It has been supposed by some that this army, like that of Carthage, was heterogeneous in its composition; that men of all nations were to be found in its ranks; and that a stern, unrelaxing discipline constituted the only *vinculum* or tie by which the naturally discordant mass was held together. There cannot possibly be a greater mistake. The Macedonians, it is true, formed but the nucleus, as it were, of the army; and, both in the reigns of Philip and Alexander, recruits were obtained in considerable numbers from the neighbouring states of Greece. But whatever shades of difference might have been produced by local circumstances and diversity of institutions, the inhabitants of all these states were essentially one and the same people; identical in origin, distinguished by like peculiarities physical and moral, and possessing a general national character. In what respects, then, can the Macedonian army be considered heterogeneous? None but Greeks were admitted into the ranks of the phalanx, or those of the light infantry and cavalry; no barbarians were received even as auxiliaries. It was composed exclusively of people of the same country and the same general character, who all spoke dialects of the same language, shared a common temperament, and were distinguished by their physical configuration, no less than by their intellectual and moral attributes, from the inhabitants of the surrounding nations. If ever there was an army, therefore, which discipline could render more completely homogeneous than another, it was that of Macedon during the reigns of Philip and Alexander; nor do we know of any modern army to which this epithet can with equal justice be applied. The British army is composed of English, Scotch, Irish, Welch, and Highlanders; the French, of Bretons, Normans, Gascons, Alsatians, Savoyards, and many other tribes; the Austrian, of Hungarians, Bohemians, Transylvanians, Croatians, and Germans; the Prussian, of Silesians, Saxons, Poles, Pomeranians, and Brandenburgians; and the Russian, of Muscovites, Poles, Sclavonians, Tartars, Circassians, Armenians, and innumerable other races; yet all these are considered national armies, and have each, in fact, a national character. But if such assemblages are to be regarded as homogeneous, we know not upon what principle the Macedonian army, composed exclusively of Greeks, can possibly be viewed in a different light, or supposed to have had no other bond of union than what was created by discipline alone.

The Theban and Achæan armies.

The only other Greek armies which seem to require notice are those of the Thebans and of the Achæan League. The Theban army, like Theban independence, may be said to have been created by Epaminondas, and to have expired when that great captain fell in the arms of victory upon the field of Mantineia. Still it is a striking example of what genius and discipline may effect, even when called to work upon the most unpromising materials. Epaminondas found it a rabble, and he left it the most formidable military force which Greece had ever yet known. He gave it that organization which rendered it victorious at Leuctra and Mantineia, and which shook to the very foundation the power of the Lacedæmonians. Aware that the Spartan phalanx was invincible by any similar formation, and that he could only hope to prevail by bringing against it a greater concentration of physical energy, he organized the Theban army in columns upon a front less than their depth, so as to enable him to direct the whole or any part against a given point of the enemy's line, and to bear it down by an irresistible superiority of force; and he adapted his tactics to this organization. At the battle of Leuctra, accordingly, Epaminondas, observing the Lacedæmonians advance their two wings before the centre, so as to form the order which the Greeks called the half-moon, instantly attacked the centre of one of these wings, and, having penetrated it, soon succeeded in throwing the whole into irretrievable confusion. Here the onset was made by one wing in column against another in comparatively open formation; and hence the Theban order of attack became the oblique, which is erroneously supposed to be a discovery of modern times. At Mantineia the Lacedæmonians carefully avoided the blunder for which they had paid so dear at Leuctra, and kept their forces more concentrated; but Epaminondas, forming the whole of his infantry in a single column, precipitated it upon a part of the enemy's line, overthrew it, and thus decided the fortune of the day. The Theban army, immediately after the battle of Leuctra, is said to have amounted to 50,000 men. This, however, is probably an exaggeration.—With regard to the army of the Achæan League, it continued insignificant for

[1] For an able and learned account of the *peltastæ*, who sometimes formed considerable bodies, particularly in the armies of Alexander and his successors, and whose reputation almost equalled that of the phalanx itself, see Guischardt's note to his Translation of Arrian's *Tactics*, in the second volume of his *Mémoires Militaires*, p. 177.

the greater part of a century after that celebrated confederacy was entered into. Aratus was the first who placed it on a respectable footing, and taught it to conquer at Caphyæ; and he was succeeded by Philopœmen, incomparably the most scientific commander of ancient times, who completed its organization, and led it to victory at the second battle of Mantineia, where the Spartans, under Machanidas, were completely defeated, and the tyrant himself slain by the hand of the Achæan chief. This victory was exclusively owing to the superior tactics and dispositions of Philopœmen; who, instructed by the successes of the Romans, had contrived, with infinite skill, to combine, in the formation and arrangement of his troops, the advantages of the legionary order with those of the phalanx. The invaluable fragment of Polybius, containing a description of the battle of Mantineia, gives no account of the numbers engaged. We learn, however, that Philopœmen having assembled the troops of the League, spent eight months in perfecting their discipline and organization before he ventured to commit them in the field against so experienced and warlike an enemy as the Spartans.[1] An army is a piece of mechanism which only acts effectively when all the parts are combined and adjusted together so as to insure the most complete concert and unity of operation; and discipline is the mean by which this important result is produced. It is in fact the art of creating a new power; and so great is its efficacy that it sometimes developes in men those qualities which it only professes to direct and regulate.

The Carthaginian army.

This remark is strikingly exemplified in the history of the Carthaginian army. That army was almost entirely composed of mercenaries, or at least of levies drawn from countries differing in language, in manners, in customs, and in character. In its ranks were to be found Africans, Spaniards, Gauls, Boians, Insubrians, Etruscans, and various other races; yet such are the fusing effects of discipline, that this apparently heterogeneous mass vanquished the Romans on the Ticino; overthrew their legions in three pitched battles, at Trebia, Thrasymenus, and Cannæ; and, if Hannibal had known how to profit by victory, might have planted the Carthaginian standards amidst the ruins of Rome. The advantages of a truly national army are great, especially in reverses: it may be beaten, but cannot easily be destroyed: and even its disasters may teach it that experience which will ultimately conduct it to victory; as happened to the Romans in ancient, and to the Russians under Peter the Great, in modern times. But, on the other hand, many instances might be produced to show, that the most effective armies may be organized out of the most discordant and unpromising materials; and that, while nothing can supply the want of discipline, discipline can almost atone for and remedy every thing. With an army composed as we have already described, Hannibal maintained, during sixteen years, the war against the Romans in Italy, without sustaining any serious reverse; nor did he withdraw, until his presence was rendered necessary for the defence of his country; which the successive defeats of the other Carthaginian commanders, both by sea and land, had uncovered, and exposed in its turn to the attacks of an invader. Finally, he was vanquished at Zama from the same cause which had rendered him so often victorious—namely, superiority of discipline: for although his military genius never shone forth more transcendently than in his last field, and although his dispositions were in all respects worthy of his high reputation, yet the raw and undisciplined levies which formed the strength, or rather the weakness, of his army, were in no condition to contend with the Roman legions, whom sixteen years of incessant warfare had improved both in discipline and experience.[2] In reflecting upon the issue of this decisive conflict, which terminated the long and sanguinary struggle between the rival republics of Carthage and Rome; and, above all, in considering the precarious nature of that power which is built on the uncertain foundation of military glory; the mind insensibly passes from the contemplation of the fate of the Carthaginian chief to that of a still greater commander, which in some measure resembles it—from the days when these warlike republics contended for the empire of the world, to our own times, when, in a new field of Zama, another Scipio conquered another Hannibal.

With regard to the numerical strength of the Carthaginian army, it appears to have varied at different times. The force with which Xantippus defeated Regulus, and made him prisoner, did not probably exceed 20,000 men; and we learn incidentally that the heavy-armed infantry which the Lacedæmonian had formed in phalanx, conformably to the tactics of his country, amounted to between 8000 and 9000 men, and were all native troops. But when the Carthaginians afterwards invaded Spain, they recruited their armies from the population of the country, and that of the neighbouring provinces of Gaul, until the total numerical strength of these must have considerably exceeded 100,000 men. Livy assures us that Hannibal set out on his expedition to Italy at the head of 100,000 foot and 10,000 horse, but that he lost 30,000 men in crossing the Alps; so that, according to the Roman historian, he must have entered Italy with about 80,000 men. But the numbers actually brought into the field completely disprove this statement: for it is admitted by Livy himself that, at Trebia, Hannibal had only 30,000 infantry and 10,000 cavalry, and that he vanquished at Cannæ with 40,000 foot and 10,000 horse. We shall be nearer the truth, therefore, if we suppose that the invasion of Italy was undertaken with little more than half the number of troops mentioned by Livy; and that the losses sustained in crossing the Alps were, in a great measure, repaired by the recruits which Hannibal drew from the Boians, Insubrians, and his other allies; a supposition which seems completely borne out by the authority of Polybius. But when the Carthaginian general set out from New Carthage for Italy he left two other armies in Spain; and, if we assume these to have been each about 30,000 strong, while the force under his own command exceeded 50,000, it will follow that, at this time, the Carthaginians had considerably more than 100,000 men of all arms in the field.—Let us now attend to the composition and organization of that strictly national force with which these well-disciplined condottieri were called to contend, and by which, after sustaining many reverses, they were ultimately overthrown.

The Roman army.

The army of Rome, in the days of her conquests, was perhaps the most perfect, certainly the most formidable, which the world had yet seen; and the superiority which it ultimately obtained over the military force of every nation to which it was opposed, seems to have been exclusively owing to the pre-eminent excellence of its discipline and organization. "Nulla enim alia re videmus populum Romanum orbem subegisse terrarum," says Vegetius, "nisi armorum exercitio, disciplina castrorum, usuque militiæ. Quid enim adversus Gallorum multitudinem paucitas Ro-

[1] See Guischardt's commentary on this battle, *Mémoires Militaires*, tom. i. p. 177.

[2] We must again refer to Guischardt, tom. i. p. 216, more especially as this very able military commentator exposes the misrepresentations of Folard, who seems to have been alike incapable of comprehending the narrative of Polybius, or the dispositions of Hannibal.

mana valuisset? Quid adversus Germanorum proceritatem brevitas potuisset audere? Hispanos quidem non tantum numero, sed etiam viribus corporum nostris præstitisse, manifestum est. Afrorum dolis atque divitiis semper impares fuimus. Græcorum artibus prudentiaque nos vinci, nemo unquam dubitavit. Sed adversus omnia profuit tyronem solertem eligere, jus (ut ita dixerim) armorum docere, quotidiano exercitio roborare, quæcunque evenire in acie, atque in prœliis possint, omnia in campestri meditatione prænoscere, severe in desides vindicare. Scientia enim rei bellicæ, dimicandi nutrit audaciam. Nemo facere metuit, quod se bene didicisse confidit. Etenim in certamine bellorum, exercitata paucitas ad victoriam promptior est: rudis et indocta multitudo, exposita semper ad cædem."[1] The military age was seventeen; and, when the exigencies of the state required it, every citizen, from seventeen to forty-six, or even fifty, was obliged to enrol himself as a soldier. Except on pressing emergencies, however, the more youthful part of the population was preferred, as that which could be most effectually trained to the exercises and formed to the discipline of war.[2] These were of the most severe description, and had for their object not merely to instruct the soldier in the use of arms, in marching, and in evolutions, but to develope and improve to the utmost his physical powers; to inure him to labour, fatigue, and hardships of all kinds; to qualify him for surmounting with ease the various obstacles and difficulties incident to a state of active warfare; to give precision and rapidity to his movements; and, above all, to create that confidence in himself, and that unbounded reliance upon the efficacy of order, subordination, and combined action, which nourish audacity, yet temper it with coolness and steadiness. Besides the use of arms, of which we shall hereafter speak, the young soldier was, accordingly, trained to the exercises of running, leaping, vaulting, wrestling, and swimming, armed as well as unarmed: he was required to perform long and frequent marches, at the rate of four miles an hour, carrying a load of sixty pounds weight: he was carefully instructed in the use of the tools necessary for throwing up all manner of field-works, particularly fortifying the camp: and, even after he had been found qualified to join the legion, he was constantly employed, while in camp, either in the practice of these manly exercises, or in acquiring greater dexterity and precision in the use of his weapons. The Roman soldier knew no intervals of idleness, and was not allowed time to indulge in dissipation. The camp was his home: war was his business: its exercises formed his amusement: its success constituted his glory. In the legion to which he belonged were concentred all his hopes, all his thoughts, and all his affections.

In raising troops to constitute the legions, the method adopted by the Romans was that which they denominated *election;* because the magistrates chose from the different tribes the citizens whom they considered best fitted for the military service. The consul or the prætor assembled in the Campus Martius, or in the Capitol, all the citizens, who were bound to concur in the formation of the legions, raised every year, conformably to a decree of the senate; and this obligation included all Romans within the age above specified, who had not served twenty campaigns as foot soldiers, or ten campaigns as horsemen or knights; with the exception, however, of the lowest class, which was exempted from military service on account of its poverty. The number of legions commonly raised was four;[3] and the first step consisted in the appointment, either by the people or the consuls, of six tribunes to each legion. The conscripts being classed according to their tribes, the magistrate, charged with the levies, then elected four successively from each tribe. Of every four thus designed the tribunes of each legion in their turn chose one, whose name was immediately inscribed in its muster roll; and this operation, which established a perfect equality in the composition of the legions, was repeated until they had received their proper complement of men. On the termination of the election each legionary individually took the *sacramentum* or military oath; swearing to be obedient to his general, and to execute his commands in all things to the utmost of his power and ability. Nor was this a vain ceremony; for the Romans, trained up in the fear of the gods, had a peculiar reverence for the sanctity of an oath. Roman citizens alone were admitted into the legions, until the time when the civil wars led to the subversion of the republic, and the violation of all established rules. Those, however, who had completed the prescribed period of service, or had attained their fiftieth year, were no longer obliged to take arms in defence of the state, and were only liable to be called out in the event of the city being threatened with some imminent danger. But these brave veterans, habituated to a military life, frequently inscribed themselves as volunteers, and thus served both as models and examples to the young legionaries, who seldom failed to profit by their experience, and generally showed an ambition to come up to their standard.

As soon as the military oath had been administered, the tribunes dismissed the legionaries, having first indicated the time and place where they were afterwards to assemble in order to be embodied. At the general muster, on the day fixed for this purpose, the youngest and poorest in each legion were selected as *velites;* the next in order were chosen as *hastati;* the class immediately above constituted the *principes;* and the *triarii* were formed of the oldest and richest citizens elected to serve in the legions; the different classes being thus arranged according to their arms, their fortune, and their age. The legion was commonly composed of 1200 *hastati*, 1200 *principes*, 1200 *velites*, 600 *triarii*, and 300 cavalry or knights; thus making its total

[1] Vegetius, *De Re Militari*, l. i. c. 1. Raphengii, 1607.

[2] "Adolescentes legendi sunt, sicut ait Sallustius: nam primum juventus, simul ac belli patiens erat, in castris per laboris usum militiam discebat. Melius enim est, ut exercitatus juvenis causetur ætatem nondum advenisse pugnandi, quam doleat præteriisse. (Vegetius, l. i. c. 4.)

[3] A consular army consisted of two legions, and of a certain number of troops furnished by the *socii* or allies of Rome. The infantry of the allies, according to Polybius, did not surpass in number the legionary infantry in a consular army, but their cavalry was double the number of the knights. The fifth part of their infantry and the third part of their cavalry formed a *corps d'élite*, called *extraordinary* or *elect*, under the immediate orders of the consul; while the remainder of the social troops were divided into two corps, one called the right and the other the left wing. Hence a consular army consisted, in Roman troops, of 6000 legionaries of the line, 2400 *velites*, and 600 knights; in social troops, of 6700 infantry of the wings, 1700 extraordinary infantry, 800 cavalry of the wings, and 400 extraordinary cavalry; making a total of 18,600 men. But when Rome had a difficult war to carry on, two consular armies were raised, and both the consuls took the field; which, in fact, happened almost every year. Lastly, when urgent circumstances required it, the consular armies were doubled and united in order to contend with a formidable enemy. Thus the Romans assembled at Cannæ four consular armies, or nearly 80,000 men, to try the fortune of arms against Hannibal; and, in the heat of the second Punic war, they raised as many as twenty-three legions, or considerably more than 100,000 men. "Alors," says Rogniat, "les armées se multiplièrent en raison de ce grand nombre de légions; les deux consuls choisissaient celles qui leur convenaient, et le commandement des autres était confié à des préteurs, à des proconsuls, et à des propréteurs." (*Considérations sur l'Art de la Guerre*, p. 29, 30.)

strength 4500 men. The tribunes, in concert with the centurions, divided the three classes of *hastati*, *principes*, *triarii*, into ten *ranks*, *manipules*, or *companies* each: the *velites* were distributed in equal portions among these thirty manipules: and the cavalry were divided into ten parts, called *turmæ* or troops. Such is the account given by Polybius, who, doubtless, describes the legion as it was constituted in his time.

The *hastati*, so called from the *hasta* or spear with which they were originally armed, commonly formed the first line in the order of battle; the *principes* were placed in the second line; whilst the oldest and best legionaries, classed under the name of *triarii*, constituted a reserve in the third line. The *triarii* were originally the only troops armed with the *pilum*, a species of heavy javelin, which will be described hereafter; and hence they are sometimes designated by the ancient historians under the name of *pilani*, while the *principes* and *hastati* are denominated *antepilani:* but these denominations necessarily ceased when the three lines adopted the same arms. The *velites*, distributed among the manipules, as already mentioned, were the light infantry of the legion, of which they formed about a fourth part; and known at first under the name of *rorarii* and *accensi*, they were afterwards called *velites*, and ultimately *ferentarii*. But the reader must be careful not to confound these light troops, which always formed part of the legion, with the cohorts of archers and slingers attached to the armies in the time of Cæsar; since the latter were merely auxiliary troops, and had nothing whatsoever in common with the legion. The legionary cavalry, composed of a body of 300 horse, denominated the *ala* or wing, and forming about the twentieth part of the legion, was divided into ten *turmæ*, of thirty horsemen each; while the *turma* was again subdivided into three *decuriæ*, of ten cavaliers each; and the whole was chosen from among the *equites* or knights, who formed one of the first orders at Rome.

When the classification had been completed, the tribunes of each legion proceeded to the appointment of centurions. They commenced by naming ten *first centurions* in each class, except that of the *velites;* after which they proceeded to the nomination of an equal number of *second centurions;* and the legionary infantry being divided into ten manipules of *hastati*, ten of *principes*, and ten of *triarii*, among which the *velites* were equally distributed, they assigned a first and a second centurion to each manipule; the first commanding the right, and the second the left of the manipule, under the orders of the first, whose place he supplied in the case of absence or death. The tribunes also named three decurions in each of the ten *turmæ* of horse; but the decurion first named had the sole command, and the two others were only his lieutenants. Thus a legion had sixty centurions or officers of infantry, thirty decurions or officers of cavalry, and six tribunes or officers of the staff. The tribunes commanded the legion each in his turn during two months; and this continued to be the practice until the epoch of the civil wars, when, for reasons sufficiently obvious, the command was intrusted to a *legatus* or lieutenant-general. The tribunes on service superintended the establishment and fortification of the camp, disposed the guards necessary for insuring its safety, transmitted to the centurions the orders of the general, took care that these were duly executed, and attended to the discipline and exercise of the troops; whilst the others were placed by the *legatus* or the consul at the head of detachments, reconnoissances, or foraging parties, and intrusted with the command of posts, or employed on particular missions, for raising contributions of money, provisions, clothing, and arms in the conquered countries; in a word, they were staff officers disposable for all kinds of service. The centurions were divided into several grades. Besides the distinction of first and second, established with reference to the manipule, they took precedence among themselves according to the relative distribution of the classes to which they belonged; so that a centurion of the *triarii* ranked above a centurion of the *principes*, and a centurion of the *principes* above a centurion of the *hastati*. And the first centurion of each class, that is, the *primi hastati centurio*, the *primus princeps*, and the *primipilus* or *primipili centurio*, commanded the whole of his class, or one of the lines of battle of the legion; which accounts for the high consideration that these three superior officers enjoyed among the Romans. They were commonly admitted to the council of the general, along with the tribunes; and the *primipilus*, the chief of all the centurions, by reason of the pre-eminence of his class, commanded the whole legion in the absence of the tribunes. Further, each centurion and decurion chose for himself, or received from the tribunes, a sub-officer to aid him in the details of the service; and we learn from Vegetius, that there was moreover placed at the head of each squad or tent of ten soldiers a *decanus* or corporal, who performed the duties of that humble rank.[1]

Such was the constitution of the legion in the time of Polybius, the friend and contemporary of the second Scipio. But an important, we might almost say a radical, change in its organization was afterwards introduced; a change which has been ascribed to Marius, and which appears to have commenced at the epoch of the wars against Jugurtha. The legions then ceased to be ranged in lines of *hastati*, *principes*, and *triarii;* for the last order of battle, according to the ancient formation, of which historians give any account, is that of Metellus against Jugurtha, as described by Sallust. From this period we always find the legions ranged by cohorts, without distinction of classes, in a double or a triple line. The classification which had been originally occasioned by difference of arms no longer served any purpose, after all the troops of the line were armed in the same manner; except to divide the legion into three large bodies of about 1600 each, including the *velites*, which formed part of them But experience proving that such bodies were too numerous to be easily directed by a single commander, and too heavy and lumbering for the exigencies of Roman tactics, their place was supplied by a number of smaller and more manageable bodies, and the legion, consequently, divided into ten cohorts, each consisting of three manipules, under six officers, who preserved their denomination and command in their respective manipules. The force of the cohort was raised from 400 to 600 men, thus making the total strength of the legionary infantry 6000; and the first cohort was composed of picked men, who were intrusted with the eagle, under the orders of the *primipilus*. A new order of battle was also adopted, the legions being commonly drawn up in two lines of five cohorts each, leaving small intervals between each cohort. But Cæsar, justly considering these *lacunæ* dangerous, and thinking the new formation deficient in solidity, preferred a continuous alignement, and recurred to the ancient formation in three lines, placing four cohorts of each legion in the first, three in the second, and three in the third line.

[1] Erant decani, decem militibus præpositi, qui nunc caput contubernii vocantur. (Vegetius, *De Re Militari*, l. ii. c. 8. See also Rogniat, *Considérations sur l'Art de la Guerre*, p. 7, et seqq. Paris, 1820.)

The civil troubles which led to the subversion of the republic produced still further changes. For a time the legionary cavalry entirely disappeared, and their place was supplied by auxiliary horse: strangers, and even slaves, were admitted into the legions, the force of which varied from 4000 to 6000 men: and the social troops disappeared by the admission of all the natives of Italy to the rank of citizens. In the imperial times, as we learn from Vegetius, the legion consisted of 6100 infantry and 726 cavalry. The decimal division of the infantry into cohorts remained the same. "The cavalry," says Gibbon, speaking of that attached to an imperial legion, "without which the force of the legion would have remained imperfect, was divided into ten troops or squadrons; the first, as the companion of the first cohort, consisted of 132 men, whilst each of the other nine amounted only to 66: the entire establishment formed a regiment, if we may use the modern expression, of 726 horse, naturally connected with its respective legion, but occasionally separated to act in the line, and to compose a part of the wings of an army."[1] This is at once clear and precise. But it has, nevertheless, been supposed, and not without reason, that when the legionary cavalry was augmented, the number of *turmæ* was proportionally increased; and that no such inequality as that mentioned by Gibbon existed between the *turma* attending the first cohort and those attached to the others. In fact the *turma* or squadron, at this period, consisted of 32, or, including the decurion, 33 men; and as the total number of cavalry belonging to the imperial legion was 726, it follows that there were in all twenty-two *turmæ*, of which four, or 132 men, were attached to the first cohort, and two, or 66 men, to each of the remaining nine. The result in both cases, however, is the same; while Gibbon's statement may perhaps be preferred as proceeding upon the more ancient division.[2]

The armour of the Roman infantry consisted of the demi-cylindrical buckler or shield, the cuirass or pectoral, the casque or helmet, and the ocrea or greave. The demi-cylindrical buckler or shield, four feet in length by two feet and a half in breadth, and constructed in the form of a tile, was composed of two or three pieces of timber fashioned and secured together in the manner of staves, covered with leather, strengthened at each extremity by a band of iron, and provided in the middle with an *umbo* or boss of metal, for the purpose of turning aside the missiles and pikes of the enemy. The casque, helmet, or head-piece of brass was variously formed, but generally fitted with projections at the base for protecting the neck and shoulders, and attached under the chin by *mentonnières*, covered with scales of brass. The cuirass or pectoral was a hollow plate of brass about a foot square, adapted to the form of the chest, and fastened with thongs of leather protected by metallic scales; but the centurions and foremost legionaries rendered themselves still more impenetrable to the steel of the enemy by using chain armour covered with brass scales. Lastly, the ocrea was a species of boot or greave, fortified with iron, and worn on the right leg, which the soldier advanced in striking his adversary.[3] Their offensive arms were the javelin, the *pilum* or heavy dart, the pike, and the sword. The sword called Spanish[4] was common to all the infantry of the legion. It had a short broad blade of excellent temper, which served either to cut or thrust,[5] and was worn by the soldier on the right thigh. The javelin belonged exclusively to the light infantry or *velites*. It was a species of dart, with a round shaft about three feet in length and an inch in diameter, shod at one extremity with iron about four inches in length, and tapering to a very sharp point. In the day of battle the light troops had each seven of these weapons, which they launched at the enemy with much dexterity and precision. When it became necessary to have recourse to the sword before the whole or any part of the javelins were thrown, the soldier passed them to his left hand, which remained free in consequence of the buckler being attached to the left arm. The light troops were also provided with bows and arrows, and slings, which they used in skirmishing at a distance. The *pilum* or heavy dart, intended to serve principally as a missile, was originally borne by the *triarii* alone, whence the name of *pilani*, but was afterwards appropriated to the *hastati* and the *principes*. Its shaft was of such a thickness as to be easily grasped by the hand;[6] and the weapon, including both wood and iron, was about seven feet in length. The iron, however, was of the same length as the wood, extending to the middle of the shaft, which was firmly inserted in it, and made fast by nails driven transversely; and it was of a square form, of an inch

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[1] *Decline and Fall of the Roman Empire*, vol. i. chap. iii. p. 13, 14, 8vo ed.

[2] "The turma of the Romans," says the Count von Bismark, "had, according to Vegetius, eight files and four ranks; *ten turmæ formed a legion*; the distances between the turmæ were equal to their front." (*Cavalry Tactics*, p. 273, Engl. transl.) It would be curious to learn in what edition of Vegetius the Count discovered that the *turma* of the Romans had eight files and four ranks, and that ten *turmæ* formed a *legion*, or brigade of *infantry* and *cavalry* united in very unequal proportions. Unless the Count has found out something to which the Romans themselves were strangers, he must have fancied that, in describing the formation of the infantry of the legion, Vegetius was speaking of the cavalry.

[3] When the Roman soldiers threw their *pila* or heavy darts, they had the left leg foremost; but when they engaged in close combat with the sword, they were taught to advance the right leg, which was accordingly protected by the iron-covered greave or boot above mentioned. (Vegetius, lib. ii. cap. 15 and 16; Justus Lipsius, lib. iii. dial. 2, *De Mil. Rom.*; Guischardt, tom. ii. p. 160.)

[4] The *gladius Hispaniensis* is thus described by Polybius:—Ἁμα δε τῳ θυρεῳ μαχαιραν, ταυτην δε περι τον δεξιον φερει μηρον. Καλουσι δε αυτην ΙΒΗΡΙΚΗΝ· εχει δε αυτη κεντημα διαφορον, και καταφοραν εξ αμφοιν τοιν μεροιν βιαιον, δια το τον οβελισκον αυτης ισχυρον και μονιμον ειναι. The name of this weapon sufficiently indicates its origin. An unknown writer, quoted by Suidas, says that "the Celtiberians excelled all others in the manufacture of swords, strongly-pointed and double-edged; wherefore the Romans, laying aside the swords which had been in use among their ancestors, replaced them, in the time of Hannibal, with the Spanish blades. But (he adds) although they assumed the form, they were unable to imitate the temper of the steel and the beauty of the workmanship." Josephus says that, in his time, the Romans had two swords—one of considerable length, which hung at the left side, and another about a foot long, which they carried on the right thigh; in other words, a sword and a dirk, like the Scotish Highlanders. Similar changes in the arms of the soldiery may be remarked every century.

[5] The Romans invariably gave the point, and derided the practice of those who depended on the cut rather than on the thrust. "Præterea non *cæsim*," says Vegetius, "sed *punctim* ferire discebant. Nam cæsim pugnantes non solum facile vicere, sed etiam derisere Romani. Cæsa enim quovis impetu veniat, non frequenter interficit; cum et armis vitalia defendantur, et ossibus. At contra puncta, duas uncias adacta, mortalis est. Deinde dum cæsa infertur, brachium dextrum latusque nudatur. Puncta autem tecto corpore infertur, et adversarium sauciat ante quam videatur." (*De Re Militari*, l. i. c. 12.) This, we believe, is still accounted sound doctrine of fence.

[6] This seems to be the meaning of the Greek word παλαιστιαιος, applied by Polybius to the shaft or helve of the *pilum*; for, taking it in its ordinary acceptation, the shaft of the *pilum* would have been four inches in diameter; a size which, considering the length of the weapon, and the weight of its iron, would have rendered it an impracticable arm. Dionysius of Halicarnassus confirms this opinion by describing the *pila* as χειροπληθη or weapons that completely *fill the hand*. Polybius compares this formidable arm of offence to a boar-spear.

and a half at its greatest thickness, but its diameter gradually diminished to the point, which was exceedingly sharp, and near to which was placed a hook or barb, that served to retain the weapon wherever it penetrated. Besides this arm, which was necessarily heavy, the soldiers were sometimes provided with another of the same kind, but less massive both in the wood and the iron, which they held in the left hand, and discharged immediately after the former. The *pilum* was a weapon peculiar to the Romans. As soon as they came within a proper distance of the enemy, they began the combat by launching these heavy darts, with a force which, from their weight and the temper of the steel points, caused them frequently to penetrate both buckler and cuirass, so as to inflict the most hideous and desperate wounds. Having discharged these missiles, the legionaries instantly drew their swords and rushed upon the enemy with the utmost impetuosity, before he could recover from the effects of the volley of *pila*, by which his first ranks were generally overthrown.[1] The pike of the *triarii*, a weapon equally adapted for attack or defence, onset or resistance, was longer, less thick, and consequently more manageable, than the *pilum*, which was of little use except at the moment of commencing battle. Armed with this weapon, the veteran reserve of the legion often awaited *de pied ferme*, the shock of cavalry as well as infantry; and Livy assures us that they seldom or never quitted their pikes in battle. "The *triarii*," says he, speaking of a particular occasion, "disfigured the faces of the Latins with their pikes, the points of which had been blunted in the combat." These *troupes d'élite*, therefore, may be considered as the pikemen of the legion; although instances are to be found where they abandoned the pike and had recourse to the sword, which was always the weapon in which the Romans placed the greatest confidence, and with which, indeed, their most celebrated feats in arms were achieved. It may be proper to add, that, although this description principally applies to the legion as constituted in the time of Polybius, and although great changes were subsequently introduced, yet the arms, offensive as well as defensive, of the legionaries, remained nearly the same; with this exception, however, that all the troops of the line were at length armed in precisely the same manner, namely, with the Spanish sword and the *pilum*.

The horse had very nearly the same armour as the foot, and they were latterly provided with offensive arms similar to those used by the cavalry of the Greeks; namely, with a lance, having a shaft resembling two cones joined together at their bases, and pointed at both extremities, and a long, large sword, suspended by a shoulder-belt at the right side. There was a time, indeed, when they had only slender lances, pointed at one extremity, and wore no cuirass; but experience soon showed the necessity of adopting the Greek arms and equipments. The Roman cavalry was generally composed of a superior description of men, denominated knights, who on all occasions displayed the greatest valour; but they seldom mustered in force sufficient to produce great results, and their organization appears to have been in many respects defective.

It is evident, that a man placed on the back of a horse, without a saddle, or stirrups to serve as a fulcrum for reaction, can never exert half his proper force, nor combine it effectively with the momentum acquired from the velocity and weight of his horse. "Ces cavaliers," says Rogniat, "ne pouvaient être choisis que parmi les chevaliers, qui formaient un des premiers ordres à Rome. L'état leur fournissait ordinairement des chevaux; mais, peu habitués à l'équitation, ou persuadés qu'on est plus fort à pied qu'à cheval, ils mettaient souvent pied à terre, pour prendre une part plus décisive aux combats sérieux. Telle était (he adds) l'opinion des Romains, de la supériorité de l'infanterie sur la cavalerie, que, non content de n'avoir qu'un petit nombre de cavaliers, ils les transformaient encore en fantassins dans les occasions critiques."[2]

The Roman generals, even in the time of the consuls, do not seem to have followed any particular order of battle, but to have changed it according to circumstances, or the nature of the enemy they had to contend with. This is evinced by the various dispositions which were made at the battles of Tunis, of Cannæ, of Zama, and many others that might be mentioned. But still the chequer order or *quincunx* was that most frequently employed in the earlier times of the republic; owing, doubtless, to the facility it afforded of forming line or column at pleasure. Leaving the *velites* or light troops out of view, as constituting no part of the main battle, the reader will observe that the manipules of the first line, or the *hastati*, were formed upon a front varying according to the depth, which was generally ten, but not unfrequently six; and that the interval between each manipule was exactly equal to its front. Thus, supposing the legion 5000 strong, a manipule of 140 men would be ranged ten deep upon a front of fourteen; and as each soldier occupied three feet,[3] the extent of front presented by a manipule would accordingly be fourteen yards. Since the first line, therefore, consisted of ten manipules, it contained of course nine intervals of fourteen yards each; exactly opposite to which, but at a considerable distance in the rear, were stationed nine of the ten manipules of the second line, or *principes*, drawn up in the same manner as those of the first, upon fronts of equal extent; the tenth manipule of the latter outflanking by the whole length of its front the right or the left wing, as it might be, of the first line. The *triarii*, of less depth than the *hastati* and *principes*, but for the most part in continuous formation, occupied the third line. Now, it must be obvious at the first glance, that this order of battle presented several important advantages. By advancing the manipules of the *principes* through the above-mentioned intervals, until they dressed with those of the *hastati*, line was at once formed: again, by moving them fourteen yards either to the right or left, the depth of the formation was doubled; while, by placing the manipules of the *triarii* exactly behind those of the *principes*, as was done when the legions were menaced by elephants, the whole was formed into columns, separated into intervals equal to their respective fronts, through which these animals, pursued and goaded by the *velites*, might be driven to the rear, without doing

[1] For a particular description of the use of the *pilum* in commencing the attack, see Cæsar's *Commentaries de Bello Civili*, lib. iii. cap. 92. The weight of this arm "ne permettoit pas de le darder de loin," as Guischardt says. It was the business of the *velites* to harass the enemy with their javelins and other missiles before the action became general. As the hostile lines approached, the light troops retired through the intervals or by the flanks, where they generally took their station; and when the former were within a short distance of each other, the *hastati* and *principes* darted their *pila*, and then rushed on, sword in hand, to close combat. Hence the proverb employed by Vegetius to describe the proximity of two armies: *Ad pila et spathas ventum est.*

[2] *Considérations sur l'Art de la Guerre*, p. 10, 11. Paris, 1820.

[3] The ranks of the manipule being also drawn up at the distance of three feet from one another, the whole space occupied by the Roman soldier was consequently nine square feet of ground; and this open order was seldom departed from, even in the charge. It is to be observed, however, that the second rank of the manipule was so disposed as to cover the intervals of the first, the third to cover those of the second, the fourth to cover those of the third, and so on to the last; in other words, the arrangement of each manipule individually was a precise type of their collective disposition in order of battle.

any mischief. Lastly, if it was desired to form the legion in three continuous lines, this was instantly effected by simply closing up the intervals between the manipules of the first and second lines; the *triarii* or reserve being, as we have already said, drawn up in a continuous formation, except when it became necessary to open a passage for elephants. And all these various evolutions were performed with a rapidity and precision which have seldom been equalled and never surpassed by the troops of any other nation.

At a later period, however, the Roman tacticians employed a different order of battle, distinguished for its greater compactness and solidity, as well as for the facility and rapidity with which it might be formed from the order of march, even in presence of the enemy. According to this method each manipule of the legion formed only a single rank in its order of battle; consequently the two classes of *hastati* and *principes*, ranged each upon its first manipule as a front, formed two lines ten deep. But as each man occupied three feet every way, and as the lines were separated by an interval equal to half the extent of their front, it is obvious that each line occupied a front of 120 yards, by from ten to twelve yards in depth; and that they were separated from each other by an interval of about 60 yards. Again, at an equal distance in rear of the *principes*, the *triarii* formed the reserve of the legion in the third line; and the whole, ranged in this manner in three lines, constituted a square order, as deep as it was broad; while the *turmæ* of the cavalry covered the flanks of the lines, and the eagle or standard of the legion was intrusted to the keeping of the *primipilus* on the right of the line of the *triarii*. This order, usually denominated *legio quadrata*, was that adopted by all skilful generals when in presence of an enemy. But the different legions composing an army were ranged upon the same principle, with reference to one another, as the different ranks of the same legion; in other words, they were formed *en echelon;* each legionary line thus making one of the sections of the column, and the baggage occupying the intervals, while the *velites* covered the flanks. In this order of march, if the enemy threatened an attack on the front, each legion in succession formed line with that at the head of the column; the second almost in an instant, the third somewhat later, and the fourth, or the most remote, in about seven minutes, which were accounted sufficient for developing the order of battle on the front. But the order of battle on the flank was of still more rapid formation. For, the baggage withdrawing from between the sections, and assembling on the side opposite to the enemy, each legion executed what is technically called a *quart de conversion* on its *hastati*, and the whole army immediately found itself in order of battle; two minutes being sufficient for the performance of this simple evolution. It seems evident, then, that the celebrated *quadratum agmen* of the Romans, which has hitherto been so often treated of, and so little understood, consisted of a certain number of *legiones quadratæ* disposed *en echelon*, or at least in column, as we have just described: and, from the advantages of this order of march, particularly its rapid convertibility into an order of battle either on the front or the flank, it is easy to understand the reason why the Roman historians have censured so severely the generals who neglected to adopt it in presence of the enemy. So much, then, for Roman tactics, as connected with the elementary formation of those brigades or divisions which constituted the units of Roman armies.

The distinguishing characteristic of the legion consisted in its astonishing mobility, united with its power of preserving its order of battle undisturbed, and of constantly rallying when forced to give way. It possessed a sort of flexibility which enabled it to adapt itself to every change and variety of circumstances; and no other military body, perhaps, ever executed so numerous evolutions in the presence of an enemy. Its attack was impetuous and formidable; but if that failed, it then displayed its most characteristic excellence, by fighting in retreat. In this way it vanquished the phalanx, although it was unable to withstand the direct shock of that dense body in the open field. At the battle where Flaminius defeated Philip in Thessaly, the Macedonian phalanx gained considerable ground on the legions; but the Romans, although forced to give way, preserved their order,—returned repeatedly to the charge,—and, even while in the act of retiring, extended their line so as to gain the flank of the Greeks. Philip durst neither accelerate his march, nor send out any detachment in pursuit; so that twenty manipules had time to turn his flank and fall upon his rear, which speedily decided the fate of the battle. As the phalanx acted with long pikes, and in close order, the least derangement caused by the ardour of the soldier in pursuit, or by inequality of ground in its march, necessarily exposed it to the legion; which, dividing itself into a number of separate corps with the same facility that it formed one corps and one line, possessed the power of attacking it on two or more sides at the same time. "La légion doit donc," says Guischardt, "être envisagée sous deux faces. Comme infanterie en bataille contre une autre infanterie, elle eut son ordonnance particulière à rangs et files ouverts, conformément à ses armes; et alors elle n'eut rien de commun avec la phalange. Lorsqu'elle a eu de la cavalerie en tête, elle cessa d'avoir son ordonnance particulière."[1] This wise distinction rendered the legion formidable alike to every nation on which Rome chose to make war;[2] but neither as infantry against infantry, nor as infantry prepared to resist cavalry, which duty was principally performed by the *triarii*, until all distinction of classes and arms merged in a homogeneous formation, had it any thing in common with the phalanx; for its victories, no less than its reverses, had demonstrated the inutility of deep formations, and showed that its real power depended on its distributive rather than its concentrative energies,—on its mobility and flexibility rather than on its weight or impulsion. Hence, on the day of Pharsalia, it was remarked, as an extraordinary circumstance, that Pompey had formed his legions ten deep; a novelty which, as every schoolboy knows, served no other purpose, on that occasion, except to add to the carnage.

In following the Romans in their wars under the emperors, we find their discipline and their tactics declining from age to age, in the same manner as they had advanced and improved. The spirit of change, though productive of some ameliorations, proved ultimately fatal to the legion. As long as the Romans continued faithful to the precepts and rules of the ancient masters, their infantry maintained its superiority: in proportion as these were departed from it declined; until at length, having lost all its distinctive qualities, it was constantly beaten and overthrown by the numerous cavalry of the barbarians. To ascribe the gradual declension and ultimate fall of this infantry to luxury, refinement, love of ease, corruption of

[1] *Mémoires Militaires*, tom. i. p. 84.

[2] The cavalry of the Parthians, though peculiarly formidable, durst not attack the legions commanded by Marc Antony, and confined itself to harassing them from a distance with its arrows. At the battle of Nicopolis, a single legion of the army of Domitius defeated and put to flight the whole cavalry of king Pharnaces; and, with a handful of infantry and some horse, Pompey defied the numerous cavalry of king Oroses.

Army. manners, or other analogous causes, is merely to indite silly common-places, displaying the most profound ignorance of history and of human nature. Its catastrophe was occasioned by the decay of discipline alone. For experience shows that hardy and effective soldiers may be formed in the most polished as well as in the rudest and most uncivilized periods of society; and that nothing more is necessary to produce this result than an uncompromising system of discipline. Accordingly, under Vespasian, and Titus, and Trajan, and Hadrian, and Aurelian, and other warlike emperors, who enforced the precepts of the ancient masters, and restored the ancient discipline, the Roman infantry regained its reputation, and proved itself as formidable as it had ever been in the best times of the republic. The corruption was not in the soldiers, but in the men by whom they were organized; in those whom the experience of so many ages, and the conquest of the world, had failed to impress with a due conviction of the value of that system of discipline by which such prodigies had been performed. "On ne peut voir sans indignation," says Guischardt, "la mauvaise ordonnance que les Romains au tems de Végece avoient substituée aux anciens modèles. Ils étoient rangés sur six de hauteur, et même quelquefois sur trois. Chaque rang avoit des armes différentes, dont la plupart étoient des armes de jet, comme des arcs et des frondes. D'un rang à l'autre il y'avait six pieds d'intervalle, et dans les files on avoit retranché les trois pied de distance, parcequ'on ne se battoit plus avec l'epée: on avoit même oublié le véritable usage du *pilum*. Le troisième et le quatrième rangs dévoient de tems en tems se détacher, et charger à la tête de la ligne, et revenir ensuite à leur poste. On ne sauroit rien imaginer de plus pitoyable. Ces deux chapitres de Végece marquent bien clairement l'ignorance de l'auteur, et la décadence de la bonne discipline chez les Romains."[1] From innovations like these, and others still more absurd which succeeded them, what results could be anticipated except those which history has recorded; namely, disgraceful defeats, calamitous reverses and, at length, the final overthrow of the Roman power itself? The legions, degenerated into a feeble militia, sold the empire which they were incapable of defending; and having neither the courage which sometimes supplies the place of discipline, nor the discipline which supplies that of mere courage, they fell an easy prey to the swarms of Goths, Huns, and Vandals, by whom it was successively overrun, and at last completely destroyed.

Armies of the middle ages.

The fall of the Western Empire, like that of a colossal structure, was succeeded by a thick cloud, which overspread Europe, covering it with darkness and desolation. All that remained of science or of art perished in its ruins, and the only relic of the catastrophe was the shadow of a mighty name. But the barbarians who had subverted the Roman power appear to have brought with them, from their forests and wildernesses, the elements of a system which was destined to thicken the darkness in which it originated; to bind Europe for ages in the fetters of the most abject thraldom; nay, even to maintain a long and fierce struggle against the reviving energies of the human mind, and the regenerative powers of society. Its foundations were laid in their peculiar character and habits, as affected by their position and their wants; and, as they had fought neither from the love of glory, to which they were insensible, nor from a thirst of vengeance, which nothing had contributed to stimulate, the only fruits they dreamt of reaping from victory were the spoils of the vanquished. The countries which all had conquered were considered the property of all, and each claimed a share proportionate to his services and the number of his retainers. Subsisting rights or possessions weighed as nothing in the estimation of these wild hordes, who sought for establishments in genial climates and fertile regions. They demanded a territorial division and apportionment, which was accordingly made upon some rude principle of equalization. But, as these lands were the reward of military service, so they were to be held by that tenure alone. The common interest and the common defence required that this condition should be annexed to the allotment, or, as it was afterwards called, the *feu*. Each great vassal of the liege lord was bound to have in constant readiness to take the field, a certain number of men, clothed, armed, and equipped at his own expense. Hence arose the *feudal system*, which, founded on military rather than civil principles, was an aggregation of petty sovereigns and petty principalities, under a nominal head, to whom all swore fealty, but few or none owned obedience; a military aristocracy, in short, under the mask of a monarchy. But this system, however well calculated to keep alive a spirit of ferocity, seemed to oppose a formidable barrier to the revival of the military art. Its maxims, necessarily hostile to the establishment of a standing army, by which the great barons might have been coerced, limited the force of the state to the contingents of feudal militia, which the crown vassals could bring into the field; a tumultuary mass, without coherence, which the first victory or the first reverse generally dispersed. During this period, accordingly, the wars of Europe were desultory and indecisive. An incursion constituted a campaign, and a foray an expedition. Armies were everywhere without order and without science; battles were gained by accident or by valour, never by discipline; while conquests, rapid as torrents, were generally as destructive and as transitory. The love of military glory was extinguished; petty wars, occasioned by baronial feuds, raged fiercely, preying upon the vitals of society; and the fruits of organized barbarism were general misery and desolation. The people were abject serfs, the barons ferocious brutes, the sovereign an absolute cipher. Anarchy, tyranny, ignorance, and spiritual thraldom, formed the characteristics of the first ages of feudalism.

The crusades.

At length, in the eleventh century, arose a monk, called Peter the Hermit, who preached with all the fervour, and more than all the success, of any known apostle, the duty of recovering the Holy Sepulchre from the infidels; and as the church lent her powerful aid to second the efforts of Peter's enthusiasm, the contagion soon spread throughout every part of Europe, and thousands of all countries rushed forward to enlist under the banner of the cross. The history of mankind affords no parallel to the madness that was thus produced, either as regards its universality or its duration. It affected all Christendom in nearly an equal degree; and, during two centuries, army after army marched for Palestine, to melt away under the sultry sun of Syria, or to be mowed down by the swords of the Saracens. But it agitated the minds of men by a new and powerful impulse; and although its essence consisted in the wildest fanaticism which had ever taken possession of the species, yet that inexplicable frenzy, combining with a spirit of enterprise and adventure, gave birth to institutions which were destined to exert a powerful influence upon the whole frame of society, and which have left a marked impression even on the manners, customs, and feelings of modern times. Viewed in a military light, the armies of the crusaders were mere

[1] *Mémoires Militaires*, prel. disc. xxiv.

tumultuary masses, impelled by fanaticism to deeds of heroic valour, but as destitute of order and discipline as their leaders and chiefs were ignorant of military science; nor had all the reverses they sustained the effect of inculcating the simplest principles of the art of war, or teaching the necessity of adopting some kind of organization. Every thing was trusted to numbers without combination, and to individual bravery exerted as chance or impulse happened to direct. And so deeply engrained in men's minds was the spirit of feudalism, and so incompatible did that spirit show itself with the slightest advancement in the military art, that the mailed chivalry of the ages immediately succeeding the crusades, although offering the finest elements that ever existed for the organization of an invincible force, appears at no time to have had any principle of effective combination, or to have been capable of acting with unity and concert in any grand operation. Yet the principal strength of armies in the middle ages consisted in their cavalry; which, composed of men of superior grade, and formidable from its bravery no less than from the armour of proof in which it was encased, easily proved itself superior to infantry without formation, and with no other discipline than that which instinct dictates even to the most barbarous tribes.

Invention of gunpowder.

But a new epoch approached. Gunpowder was invented, or at least improved, by Berthold Schwartz, a Franciscan monk of Cologne, and was first employed in warlike operations in the early part of the fourteenth century. This discovery, as Guibert justly remarks, did not lead to any *immediate* improvement in the art of war: indeed a century and a half was necessary in order to make the use of fire-arms general; but it is nevertheless to be considered as the real cause of the complete reform which was at last effected in the constitution of armies, as well as in their discipline and tactics. Since the first employment of gunpowder, there have been *seven principal periods* in the history of the military art.

First period.

The first begins with the employment of cannon, and extends to Charles VIII.'s campaign in Italy; or from the early part of the fourteenth until towards the end of the fifteenth century. This period, during which the art of war began to revive from the state of barbarism into which it had sunk since the downfall of the Roman empire, includes the wars of the Spaniards against the Moors, of the English against the French, and finally, of the Italian republics against each other. The cavalry, composed of the nobility and gentry, still constituted the flower of armies, and formed the chief support of princes and their kingdoms. At the storming of fortresses, or when important posts were to be occupied and defended. and a bold, determined soldiery was required, the knights dismounted and fought on foot. They were the dragoons of that age. Each knight was attended by his esquire; and, besides these there were also archers, generally the vassals of the knights, who, being more lightly armed, and riding smaller horses, served as a kind of light horsemen. At the beginning of the fourteenth century, indeed, the distinction of heavy and light horse was common in European armies. The former, consisting of tenants *in capite*, holding of the crown by tenure of military service, or their substitutes (*servientes*), were denominated *men-at-arms*, from their being armed *cap-à-pied;* the latter, composed of yeomen, were named *hobilers*. The knights rode what were denominated war-horses, which, like their riders, were covered either with chain or plate armour, or with both; and these men of iron carried a long and powerful lance armed with an iron head, a long sword, a short sword, a dagger, and a mace or battle-axe.[1] Their formation for combat was exceedingly simple. They fought man to man; each armed knight singling out his opponent, and riding against him with his couched lance, in order to throw him out of his saddle, or to make him prisoner. The esquires, or armour-bearers, followed as a second rank, or at least acted as seconds to the knights, whom they assisted in battle, bringing them fresh arms and horses when required, and seeking opportunities of distinguishing themselves in order to obtain the honour of knighthood. Nothing, however, was known of scientific movements, until Charles the Bold compiled an exercise book in 1473, instructing cavalry how to attack in close and extended order, or to link the horses and fight on foot. An engagement was generally commenced by single knights riding forward and challenging opponents from the hostile army; and the result of these single combats sometimes determined the fate of the day.[2]

Second period.

The second period, from the campaign of Charles VIII. in Italy to the beginning of the wars in the Netherlands, or from the end of the fifteenth to the middle of the sixteenth centuries, comprises the wars of the French, Spaniards, and Germans, in Italy. During this period chivalry gradually declined, and war began to assume a new aspect. At the close of the contest with England in 1445, Charles VII. of France established the first standing army, consisting of 16,000 infantry and 9000 cavalry, divided into fifteen *campagnies d'ordonnance;*[3] he appropriated funds for the payment of these troops, and appointed officers to discipline and command them; and, although apprehensive at first as to the success of the experiment, he at length succeeded in organizing a force, which enabled his successor to repress the turbulent spirit of the feudal aristocracy, to strengthen the power of the crown, and to carry on foreign operations with a consistency and vigour hitherto unknown. The Italian campaign of Charles VIII. proved the superiority of a standing army over an assemblage of feudal militia, and consequently established its reputation. With a force of about 20,000 men, he overran the whole of Italy; and, had his ambition been equal to his success, or rather had he known how to reap the fruits of victory, he might have rendered himself permanent master of that country. Other nations imitated the example of France: a change took place in the military system of Europe: the practice of calling out knights ceased of itself: and mercenary, or at least paid troops, regularly disciplined and organized, became the only force that was trusted or employed. The characteristic of this period was deep formation, both in the cavalry and the infantry.

Third period.

The third period comprehends the great war of independence, carried on by the Netherlanders, in order to emancipate themselves from the yoke of Spain; and it extends from 1568 to the general suspension of hostilities in 1609. Here fought, on one side, art, and an army formed by the experience of more than half a century of war, under Charles V. and his son Philip II.; on the other, the inhabitants of the Low Countries, living only by trade and the arts of peace. A people, consisting chiefly of manufacturers and merchants, inhabiting a country of small extent, and already much exhausted by a long-continued exercise of tyranny and oppression, scrupled not

[1] Meyrick's *Critical Inquiry into Ancient Armour*, vol. i. p. 174. Chain-armour first became covered with plates at the beginning of the fourteenth century; but entire plate-armour did not make its appearance until about a century after.

[2] The only military productions of this period were the regulations of Charles the Bold, above-mentioned, with those of Louis VII. of France, and of John Ziska, general of the Hussites.

[3] See Père Daniel, vol. i. p. 155.

to draw the sword, in defence of their liberties, against the richest monarch of the age, the sovereign of Spain and the Indies, and master of the most numerous as well as the best-disciplined forces, commanded by generals distinguished above their contemporaries by their skill in the art of war.[1] A more unequal contest cannot well be imagined; and never was the issue of any dispute more contrary to what the parties had reason to anticipate. But the struggle was protracted; and in proportion as the Netherlanders were formed to war, the bravery and discipline of the Spaniards relaxed. Under the skilful tuition and able conduct of Nassau, the foe which had at first appeared so contemptible to the haughty Spaniards, tore the laurels from their brows, and at length drove them, defeated and disgraced, from the country which had suffered so long under their grinding oppression and their insolent misrule. This war was followed by great changes, both in the organization and tactics of armies. The cavalry was divided into cuirassiers and light horse; the use of the lance was discontinued,[2] and its place supplied by the sword and pistol for the heavy, and the carbine for the light horse; and these were now trained to execute a variety of movements and manœuvres at full speed. The infantry was also placed upon a better footing, both in respect to discipline and formation; although the prejudice in favour of columns or masses seems still to have continued, notwithstanding frequent experience of their inutility, as well as of the destruction to which they were exposed from the concentric fire of artillery.

Fourth period.

The fourth period comprises the Thirty Years War, the pretext for which, according to Bulow, was the happiness of heaven, but the motive the goods of the earth: it extends from 1618 to 1648. The peace which had terminated the struggle for independence in the Low Countries, after a protracted contest of above half a century in duration, lasted only nine years; when a new war broke out, which can only be considered a continuation of the former. The hero of this war was Gustavus Adolphus; and he, like Prince Maurice of Nassau,[3] was the creator of new tactics. This warlike monarch departed from the dense formation of his predecessors, and drew up his infantry six deep; which was considered an innovation that nothing but his success could justify. His opponents, Tilly and Wallenstein, formed their infantry in solid masses thirty deep; which, nevertheless, proved unable to contend with the linear formation of the Swedish troops. Until about the middle of this war, it still continued the practice to form cavalry in from four to eight ranks. But Gustavus also departed from this rule, and formed it in three ranks; although it appears from Harte, that, at the battle of Leipsic, it was drawn up four deep, probably on account of the dense formation of the imperial cavalry, which was formed in eight ranks. In the intervals he stationed platoons of infantry, fifty and upwards strong, as well as light guns; doubtless from a conviction that cavalry, unless supported, were unable to contend with infantry. His great object appears to have been, to give greater mobility to the two principal arms of a military force, and thus to gain in celerity of movement what he had lost in weight or impulsion. He knew that the momentum would remain the same, if the motion was increased proportionally to the diminution in weight.

Fifth period.

The fifth period comprehends the wars of the French in Italy, in Germany, and in the Netherlands, as well as the northern and Turkish wars, and embraces a period of ninety years; namely, from 1648 to 1738. The peace of Westphalia put a period to nearly a century of war. The results of this conflict were the secularization of ecclesiastical property, the complete establishment of the Protestant religion, the recognition of mental freedom, the decay of the Papal power throughout Europe, and the triumph of national independence. But during the long-continued struggle in Germany, two hereditary enemies appeared,—the Turks and the French. The former were expelled in a single campaign, and never again attempted any serious invasion. The latter entered upon a series of wars of which we have not yet probably seen the termination. The ambition of Louis XIV., however, and the wars to which it gave rise, rapidly developed the art of carrying on military operations, and formed generals whose names adorn military history. Opposed to a French Turenne, Luxembourg, and Condé, stand Montecuculi, Marlborough, and Eugene of Savoy; Louis of Baden may rank with Catinat or Vendôme; and many other generals of eminence illustrate this period, which was less remarkable for changes in the constitution and organization of armies than for the talents displayed in conducting their operations in the field. It was the era of great commanders. In the north the Swedes, Poles, Brandenburgians, and Muscovites, fought alternately on the plains of Poland and the steppes of the Ukraine. Under Charles XII. the Swedish infantry attained a high degree of perfection, and proved uniformly successful until it was so rashly committed at Pultowa; while the cavalry, without defensive armour, which the chivalrous monarch rejected, consisted almost entirely of dragoons.[4] The principal improvements of this period, however, are chiefly due to the French, who made rapid advances in all the branches of military science.

Sixth period.

The sixth period includes the three Silesian wars namely, from the beginning of the first Silesian war in 1740, to the breaking out of the French revolutionary war in 1792. For a century previous to this, Prussia appears to have been chiefly employed in preparing herself for the brilliant part which she acted under Frederick II. To the celebrated elector, Frederick William, the Prussian military power in a great measure owed its origin. This prince grew up, as it were, in a camp, and, even in his boyish days, was present at the sieges of Breda and the Schenkenschantze. Arrived at the government, he endeavoured to infuse a new spirit into the army; and so well did he succeed, that, in 1672, he was enabled to promise the republic of Holland an auxiliary force of 20,000 men. At the period of his death the elector left behind him a well-organized army of 30,000. When Frederick the Great (or, as he

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[1] Watson's *History of Philip II.* vol. i. p. 428.

[2] "La lance," says Montecuculi, "est la reine des armes pour la cavalerie." (*Mémoires*, liv. i. c. 2.) And this opinion seems to be gaining ground at the present day; for experience has shown, that cavalry can never make any serious impression by means of firearms, while, with swords alone, they are wholly unfit to contend with infantry.

[3] Bismark's *Cavalry Tactics*, p. 307; Guibert, *Essai Général de Tactique*, p. 68.

[4] Charles XII., not content with making the cavalry, without any connection with or dependence upon other arms, but from confidence in itself, charge the enemy's horse at full speed, without firing, led it equally against intrenchments and batteries, and always with success. "He knew," says Count Bismark, "that by the rapidity of motion, the natural vivacity of the majority of mankind is increased, and, often mounting to a blind fury and foolhardy enthusiasm, leaves no time for consideration or calculation of danger; that at such a moment death loses its terrors, and *Victory!*—but with living colours—presents itself to the soul of the wildly-rushing warrior." (*Cavalry Tactics*, p. 319, 320, 321.) At the same time Charles appears to have had a love of fighting for its own sake; and it was probably this peculiarity of temperament, as much as any calculation of results, which gave to his movements that impetuosity, which neither natural nor artificial obstacles could check or resist.

Army.

is called by the Germans, *der Einzige*, the Unequalled) ascended the throne, he found the army about 80,000 strong, and drilled to a precision of movement, as well as a rapidity in firing, until then unknown. This was owing to the exertions of Prince Leopold of Dessau, who may be considered the founder of the modern system of tactics, having invented the iron ramrod and the equal step,—reduced the formation of the infantry from four to three ranks, thereby increasing the effect of musket fire,—and, in short, laid the foundation of the system which Frederick afterwards improved, by giving to infantry-movements greater lightness and facility. With an army thus prepared for action, Frederick took the field in 1740. But the first two wars passed quickly by; and the intervals of peace were employed in reforming whatever experience had shown to be defective in his system,—in practising a vast variety of deployments,—and, above all, in introducing that celerity of movement which had become so essential in modern armies, with reference both to their numbers and the extent of their front. When the third Silesian or Seven Years War broke out, Frederick, forsaken by his allies, and menaced on all sides by powerful enemies, seemed on the very verge of destruction. But if he stood alone, he stood unmoved, like the oak, braving the storm, and conscious of the power to weather it. Nor was he without some peculiar and decided advantages. On the one hand, his natural *coup d'œil*, which was perfect; the unity and power of his will; the habit of his troops to remain firm in all situations, and to execute every movement with precision, even in the very tumult of battle; the never-shaken confidence in their leader, and the enthusiasm with which he was regarded by them: and, on the other, the division, weakness, and want of system or connection in the enemy's plans of operation; their partial and lukewarm mode of execution; together with the inferiority of their troops in organization, and of their commanders in genius:—these were the causes which enabled Frederick to retire from this bloody seven years conflict with a prodigious increase of fame, and without the loss of an acre of territory.[1] "Depuis la guerre de la Succession," says Guibert, "on n'avoit pas vu tant d'armées en campagne et réunies contre un seul prince. Sa science et leurs fautes furent le contrepoids de tant de forces. Jamais guerre ne fut plus instructive, et plus féconde en événemens. Il s'y fit des actions dignes des plus grands capitaines, et des fautes dont les Marsin auroient rougi. On y vit quelquefois le génie aux prises avec le génie, mais plus souvent avec l'ignorance. Partout où le roi de Prusse put manœuvrer il eut des succès. Presque partout où il fut réduit à se battre, il fut battu: événemens qui prouvent combien ses troupes étoient supérieures en tactique, si elles ne l'étoient pas en valeur."[2] Such was the character of the Prussian army of this period, and such the military genius of the great monarch by whom it was commanded. Mere tactical details are foreign to the object of this article, and therefore we abstain from entering into them, excepting in as far as they may seem necessary to throw light upon the constitution and composition of armies. That of Prussia was long considered a model for imitation. Under Generals Siedlitz and Ziethen its cavalry attained a degree of perfection unequalled either before or since. "There was but one Seidlitz," says Count von Bismark. In playing the mighty game of war, its infantry was also superior to any other of that age; and if subsequent events somewhat tarnished its reputation, it has never ceased to be one of the best organized and most completely equipped bodies of foot in Europe. The Austrians, as their wont is, only improved on compulsion, and when fairly beaten out of their old system of masses and deep formations.

Seventh period.

The armies and the science of this period, however, were destined to be far outnumbered and surpassed in the seventh and last, which embraces the military systems and establishments of our own times. These, accordingly, we shall now proceed to describe in detail; confining our accounts principally, if not exclusively, to their actual rather than to their former condition and strength; and commencing with the army of France, which has not only played a most conspicuous part since the commencement of the revolutionary wars, but has latterly served as a sort of model on which the other armies of Europe have been more or less formed.

French army.

From time immemorial, the Gauls were inhabited by a race of men distinguished for their bravery. Hardy and enterprising under the two Brenni, obstinate and persevering in their attacks against Cæsar, we find them cutting a conspicuous figure as auxiliaries in all the wars of ancient Rome. They passed through the middle ages with equal distinction; and if they were forced to yield to the irruption of the Franks, the amalgamation of the two nations had only the effect of adding to their energy. The wars of Charlemagne and the crusades; the successive invasions of Italy by Louis XII., Charles VIII., and Francis I.; and, lastly, the struggles maintained against all Europe by Louis XIV., showed what might be expected from French armies when properly commanded. But the fatal results of the Seven Years War, the wretched intrigues of the court of Louis XV., and still more the spirit of infatuation which appears to have become endemic after the disgraceful Hanoverian expeditions, eclipsed, in an instant, ages of glory, and rendered the army of France an object of ridicule to Europe. After the peace of 1762, some measures were taken with the view, as was pretended, of remedying the supposed defects in the constitution of the army, and restoring its character. But the French ministry of that day, ignorant of the real circumstances which had led to its successive defeats, and incapable of comprehending the dispositions and strategical movements by which success in war is attained, contented themselves with searching into the most minute details of discipline and instruction for the causes of failures which were solely attributable to a bad choice of generals, and a faulty direction of great operations. They imagined that the armies of Frederick had triumphed in consequence of oblique marches, the particular cut of their uniforms, and a thousand other absurdities which it would be impossible to credit, were not the amusing discussions of that period embodied in public documents of unquestionable authenticity; they disputed about ployments and deployments *en tiroirs*, about *tranches* and *plesions*, about a Prussian order and a French order; they formed camps in order to judge of the advantages of these different systems; and they fancied that they had discovered the sublime of the art in the mechanism of the instruction of platoons.[3]

[1] Bismark's *Cavalry Tactics*, p. 323.

[2] Guibert, *Essai Général de Tactique*, tome i. p. 77, 78.

[3] "On étoit si fort engoué de tout ce qui ressemblait à la tactique Allemande," says Jomini, "qu'il suffit á cette époque de porter un nom Tudesque pour faire une fortune militaire. Un certain capitaine Pirch, sorti des rangs de l'armée Prussienne, passa pour un émule de Frédéric, sur la simple présentation d'un mémoire dans lequel il donnait des idées pour aligner des bataillons sur les drapeaux; on se crut heureux qu'il daignât accepter un régiment et l'instruire suivant sa méthode." (*Histoire Critique et Militaire des Guerres de la Révolution*, tom. i. p. 214.) Under the government which promoted Pirch, and indeed under that which succeeded t Kléber, Moreau, and even Napoleon himself, would have been condemned to an eternal nullity.

"Encore un pas retrograde," says Jomini, "et les troupes Françaises se fussent trouvées au niveau des soldats du pape."[1] But the American war gave a check to these mischievous fooleries, and revived the spirit of emulation, which is the source of the most brilliant feats in war; while the expeditions to Grenada and St Eustatius, together with the campaigns of Lafayette, Saint-Simon, and Rochambeau, in a great measure restored the reputation of the French arms, and prepared the way for still more important achievements. The staff, the government, and the *faiseurs* were still divided between different systems. But while the chiefs were perplexing themselves with theories, the troops improved both in discipline and manœuvres; and had it not been for the repeated shocks which their organization experienced in consequence of frequent changes of ministry, and the introduction of certain radical innovations, which completely broke up the old battalions in order to amalgamate them with new levies, Louis XVI. would have possessed an army capable of defending the monarchy, and might have been able to restrain and resist that revolutionary frenzy to which he was destined soon to become a victim. In consequence of the disorganization thus introduced, the regiments of the line were in a wretched condition at the breaking out of the war in 1792. But a single measure saved them from destruction. The nomination officers taken from the *tiers-état* filled the ranks with an ambitious and warlike youth, burning to distinguish itself; while emulation, the chances of preferment, and the love of country, supplied for a time the want of discipline, and formed powerful motives for stimulating improvement.

At the end of the year 1791, the French infantry consisted of 105 regiments of two battalions each, 14 battalions of light troops, and 170 battalions of national volunteers; or 394 battalions in all. By the decree of the 5th May 1792, the number of the volunteer battalions was raised to 200, and the strength of each was increased from 226 to 800 men. The cavalry was composed of two regiments of carabineers, consisting of four squadrons each; 24 regiments of heavy cavalry of three squadrons each; 18 regiments of dragoons of three squadrons each; 12 regiments of chasseurs of four squadrons each; and 6 regiments of hussars of three squadrons each; in all 206 squadrons. So that the total strength of the French army at this period did not exceed 160,000 infantry, 35,000 cavalry, and 10,000 artillery; while 20,000 men were still wanting to bring the different regiments to their full complements. But this deficit was soon supplied by the multitude of volunteers who flocked to the national standards when the duke of Brunswick invaded France at the head of the Prussian army.[2] The revolution, however, had not yet developed its energies; nor had the world as yet any suspicion of the prodigies which the system of terror, afterwards organized, was destined to achieve. In 1795, France presented the formidable aspect of a vast camp. The decrees of the 23d August and the 5th September 1794 had hurried the whole youth to the frontiers. Nearly 1,200,000 men were in the pay of the republic; and, after deducting those employed in accessory services, and in the navy, the number of combatants in the field cannot have amounted to less than about 700,000. The official state of the force of the French armies, as at the 5th April 1794, presents an aggregate of 794,334 men, including garrisons, but exclusive of the army of the interior, whose head-quarters were at Paris; which, allowing one fifth for those in the depôts and for the sick, would give an effective force, present under arms, of at least 650,000 men; the most formidable which Europe had ever seen assembled in the field. "Ce dévelopement de forces, sans exemple dans les annales modernes," says Jomini, "tenait d'autant plus du prodige, que la nation se trouvait livrée à tous les déchiremens d'une guerre civile, et aux persécutions d'un gouvernement odieux. Mais ce ne fut pas aux levées seulement que ces efforts se bornèrent: tout ce qui compose les élémens de la puissance nationale, avoit été porté à un degré de tension inconnu dans les siècles modernes."[3] Nor did the "prodigy" stop here. In the month of March 1795, France had ten armies in the field, the active force of which amounted to 449,930 combatants, besides 120,850 in garrisons, and 388,450 sick, prisoners, or detached; in all 959,190 soldiers. But the active force, or number present under arms, did not form the half of the effective, and scarcely a third of the complete military strength of France at that period; for, as 200,000 men were still wanting to bring the effective force up to the full establishment, and as the most active measures were in progress to make up the deficit, the total number of Frenchmen under arms in 1795 cannot have fallen much short of 1,100,000 men. It will not be denied, therefore, that the *Comité du Salut Publique* possessed extraordinary energy, and that terrorism proved the salvation of France.

But this state of exertion was too violent to be of long continuance; and neither the population of the country, nor its exhausted resources, were sufficient to maintain so enormous a force in the field. Accordingly, in the succeeding years of the republic, the aggregate of the different armies seldom exceeded 480,000 effective men, and generally fell short of this number. But when Napoleon had mounted the throne, and had organized the system of conscription, he obtained an unlimited command over the whole of that part of the population capable of bearing arms; and as he acted upon the principle, first recommended by Cato, of making war support itself, he was not only able to repair the losses sustained in his various campaigns, but, on most occasions, to take the field with a predominating superiority of numbers. The establishment of the French army, in 1805, amounted to 341,412 infantry of the line, 100,130 light infantry, 77,488 cavalry, 46,489 artillery, and 5445 engineers; making a total of 650,964 men, or a force equal to that organized by the terrorists in 1794 and 1795. But this establishment was afterwards greatly increased; and it is calculated that, at the time of the Russian campaign, there were in the depôts, in the hospitals, and in the field, not less than 1,200,000 men, of whom about 850,000 might be considered as effective. Hence, we are enabled to account for the extraordinary phenomenon of Napoleon's appearance in Germany at the head of a new and formidable army, within a few months after the annihilation of his veteran masses amidst the steppes, snows, and frosts of Russia, and making head for more than a year afterwards against the utmost efforts of the allied powers.

One of the first cares of the Bourbons, on their second restoration in 1815, was to re-model the army, and place it on a footing adapted to the new order of things. The most obvious maxims of policy recommended a proceeding which alone could give stability to the restored dynasty. But such changes are necessarily the work of time; and we need not therefore wonder that nearly ten years should have elapsed before the important object was accomplished. The French army was re-organized, augmented, and placed on a new footing, in virtue of three royal ordonnances, dated the 27th February 1825; the first of which related to the infantry, the second

[1] *Guerres de la Révolution, ubi supra.* [2] *Ibid.* tom. i. p. 224–25. [3] *Ibid.* tom. v. p. 29.

to the cavalry, and the third to the artillery and engineers.

But, in 1830, the Bourbon dynasty was again expelled from the throne. Louis Philippe, the son of the famous Duc d'Orleans (Egalité), was proclaimed king of the French; and again the army was re-organized. The policy of the new French king led him to find employment for the army, and the conquest of Algeria soon furnished occasion for its increase, and the employment of his sons in foreign commands. Louis Philippe was ejected in 1848 during a sudden and violent republican movement; and for four years France was a species of democracy, ruled by an assembly with a military president, which, in its turn, in 1852, was succeeded by an empire. The present ruler, the nephew of Napoleon I., was elected emperor by seven millions of votes; and as, from the peculiarity of his personal position, his views of foreign policy, and the commencement of the war with Russia on behalf of Turkey, it became necessary to augment and partially reconstruct the army, it has now been placed upon the following footing:—

The etat-major, or staff, consists of 700 officers, including the marshals, generals, &c., and an "intendance militaire" of 240 persons. Of the general officers there are two grades —generals of division and generals of brigade. There are 90 of the former and 180 of the latter.[1]

The British system of making general officers the nominal colonels of regiments, is utterly unknown in the French army. Every general, without exception, is either an officer or commander of the legion of honour. The corps of the etat-major consists of 25 colonels, 25 lieutenant-colonels, 90 chefs-d'escadron, 140 captains of the first class, 140 captains of the second class, 100 lieutenants. These are attached to the different military divisions, and fill all the regular staff appointments. All aides-de-camp are appointed from this corps. Many of them are employed on the great military survey; and there is either a captain of the second class, or a lieutenant appointed to every regiment, both of cavalry and infantry.

The strength and composition of the French army are at this moment (1856) as follows:—

Imperial Guards.

1 Regiment of Foot Gendarmerie.
2 ... ... Grenadiers.
2 ... ... Voltigeurs.
1 ... ... Zouaves.
1 Battalion ... Chasseurs.
Total, 6 Regiments of 22 Battalions of Infantry.
100 Horse Guards.
1 Squadron of Gendarmerie.
1 Regiment of Cuirassiers.
1 ... Guides.
Total, 14 Squadrons of Cavalry.
1 Regiment of Foot, and 1 of Horse Artillery.
3 ... Engineers.
2 Companies of Workmen.
1 Squadron of the Trains d'Equipage, or Transport Corps.

Infantry.

102 Regiments of the Line.
20 Battalions of Light Infantry.
3 Regiments of Zouaves.
3 Battalions of African Light Infantry.
4 Regiments of Foreign Legion.
1 Regiment of Algerian Tirailleurs, or Sharpshooters.
6 Battalions of *Tirailleurs indigénes*, or natives of Africa.
12 Companies of Discipline—

Making a total of 461 battalions, of 2904 companies, besides 116 companies and 30 sections *hors rang*, not yet incorporated with the regulars.

Cavalry.

2 Regiments of Carabineers.
10 ... Cuirassiers.
12 Regiments of Dragoons.
8 ... Lancers.
12 ... Chasseurs.
9 ... Hussars.
4 ... Chasseurs d'Afrique.
3 ... Spahis.
Total 374 Squadrons, besides 62 Platoons not yet incorporated.

Artillery.

5 Regiments of Foot.
7 ... Mounted.
4 ... Horse Artillery.
1 ... Pontonniers.
12 Companies of Workmen (ouvriers).
2 ... Armourers.
Total 17 Regiments, and 227 Batteries.

Engineers.

3 Regiments of Troops (Sappers and Miners).
2 Companies of Workmen, besides
3 ... not yet organized.

Troupes de l'Administration.

14 Sections of Workmen.
6 Regiments of Transport or Waggon Trains.
3 Companies of Workmen attached to the Trains.

Sedentary or Stationary Troops.

25 Legions of Imperial Gendarmerie.
1 Legion of Algerian Gendarmerie.
4 Companies of Colonial Gendarmerie.
1 Legion of the Paris Guard.
7 Companies of Firemen.
9 ... Cavaliers of the Remount.
1 ... Veteran Gendarmes.
5 ... Veteran Subalterns and Fusiliers.
5 ... Veteran Gunners.

The staff of each regiment is the same, viz., 1 colonel, 1 lieutenant-colonel, 2 chefs-d'escadron, 1 major, 1 captain instructor, 2 captains adjutants, 1 major-captain treasurer, 1 sub-lieutenant assistant-treasurer, 1 captain d'habillement, 1 porte-etendard—a sub-lieutenant, 1 lieutenant, or captain of the etat-major, 1 surgeon-major 2d class, 1 surgeon aide-major, 1 veterinary *en premier*, 5 captains commandant, 5 lieutenants *en premier*, 15 sub-lieutenants, 5 captains *en second*, 5 lieutenants *en second*, making altogether 51 officers in every regiment; some of the subalterns, however, of each, are either officers of instruction, or pupils at the great cavalry school at Saumur. The term major is not, as with us, a grade of army rank; it is only used regimentally; the major is a chef-d'escadron in the cavalry, and a chef-de-bataillon in the infantry, and wears the same uniform. The terms used for the non-commissioned officers in the French cavalry differ much from those in use in our service; and it is very difficult to compare the two together—some of their functions being so entirely distinct. The adjutant sous-officier is a squadron sergeant-major; maréchal-des-logis chef is a quarter-master sergeant; maréchaux-des-logis and maréchaux-des-logis-fourriers are sergeants-major; brigadier-fourrier is a sergeant; brigadier is a corporal; the adjutant sous-officier is distinguished by one gold epaulette, if the officers wear silver, and *vice versa;* the other non-commissioned officers have the same distinctive marks as in the infantry.

The *French Artillery*, in its organization, differs considerably from the English; instead of being one corps, it is divided regularly, like the line, into regiments which have nothing whatever to do with each other. These regiments are all exactly on the same footing, the horse artillery not forming a separate regiment but according to the exigencies of the service; a certain number of batteries in each regiment are horse. The artillery divisions of France do not correspond with its military divisions. There are nine altogether; eight in France itself, and the ninth comprising the three provinces of Algeria. Each division is commanded

[1] *Annuaire Militaire de l'Empire Français pour l'Année* 1855.

by a general of brigade, and is again divided into two or three *directions*, at the head of each of which is a colonel. There are a considerable number of officers on the staff, from the number of government works which are under their superintendence, there being not less than 17 establishments for making powder and refining saltpetre, and more than a dozen *arsenals de construction* and *manufactures d'armes;* most of these have foundries attached to them, and are all under the superintendence of the artillery. The *Comité Consulatif de l'Artillerie* is in some respects the French Board of Ordnance. As its name implies, it is more a board of advice than of practical interference, as there is a bureau belonging to the minister of war from which the actual orders emanate; the Comité Consulatif consists of 5 generals of division, and 3 generals of brigade. The establishment of a battery is very similar to that of a company of British artillery—there being a captain-commandant, a captain *en second*, a lieutenant *en premier* and a lieutenant *en second;* the gunners and drivers are not the same as with us, but are quite distinct from each other, there being a certain number of each to every battery according to the nature of its service. A battery may be in three positions, either a horse battery, where all the men are paid alike; a mounted foot battery, where the drivers are paid like the horse battery, but the gunners much less; or a dismounted foot battery, in which, of course, there are no drivers; as in the cavalry the corporals are termed brigadiers, and the sergeants fourriers, which is literally harbingers. The staff of a regiment of artillery consists of: 1 colonel, 1 lieutenant-colonel, 7 chefs-d'escadron, 1 major, 1 riding-master—a captain, 2 adjutants-major—captains, 1 clothing officer—a captain, 1 treasurer—a captain, 1 assistant-treasurer, 1 sub-lieutenant, 1 lieutenant of the etat-major, 1 surgeon-major, 2 assistant-surgeons, 1 veterinary *en premier*, 32 captains, 32 subalterns. A horse battery consists of 4 guns, 8-pounders, and 2 howitzers, 15 centimetres in diameter, which is about ½ of an inch more than the English 24-pound howitzer; each gun and each waggon is drawn by six horses, which, with the two extra waggons and the spare team, make 90 harness horses for each battery. The horses are generally very good, and they pay considerable attention to their being properly matched. The mounted foot batteries consist also of four guns, either 8 or 12 pounders, and two howitzers; the guns and waggons have four horses each. The *pontonniers* (pontoon men) are like our sappers and miners; the men admissible to the corps must understand some trade that is likely to be useful to the service. There is one company generally in Algeria, and the other companies with the headquarters are at Strasbourg in time of peace. The uniform is the same as the artillery, and they are officered indiscriminately with the other regiments. The companies of artillery workmen are employed at the different foundries and arsenals; there are 2 captains and 2 lieutenants of artillery attached to each company, and their uniform is the same; some of these companies are employed in Algeria.

The *Engineers* form a distinct corps altogether, and are not, as with us, merged into the Ordnance; in fact they have no more to do with the artillery than they have with the cavalry and infantry; they have their *Comité Consulatif* of 8 generals, and their separate bureau in the office of the minister of war.

The *Troupes du Génie* are the same nearly as our sappers and miners, and are officered in the same manner by the engineers. The engineer divisions of France are neither the same as the military nor as the artillery divisions. There are 21 districts which are termed *directions*, in France. Each of these is under the superintendence of a colonel, who has from 4 to 14 officers under him, either field-officers or first captains, according to the number of fortified places or towns where there are barracks in the direction. Algeria is divided into three directions, according to its provinces, and has besides an engineer staff; not including the officers commanding the companies of sappers, there are about 36 engineer officers in the colony at present. The engineers are the only army corps who have anything to do with the other French colonies. The *Infanterie de la Marine* perform all the colonial duty apart from Algeria. This they can do very well with a small force, as the colonies are few and comparatively insignificant. Those in which officers of the engineers are stationed are—Guadaloupe and Martinique, in the West Indies; Cayenne, in Guyana, South America; Senegal, Ile de la Reùnion, republicanized from the Ile de Bourbon; Nossibè, and Madagascar; Mayotta, one of the Comora Islands, between Madagascar and the coast of Africa; Oceanie, the Marquesas, and Tahiti. The *Troupes de l'Administration* are divided into two sections—the first is the battalion of government workmen; the second section is called the corps des equipages militaire. This corps bears nearly the same relation to the commissariat that the sappers do to the engineers; the French government not being much in the habit of obtaining their supplies through the medium of contracts, are obliged to keep very large establishments of their own. For instance, the whole of the bread that is supplied to the troops in Paris comes from a government factory, nearly opposite to the Hotel des Invalides. This is all done by the workmen of the first section; the qualification required of every person entering the corps is, to be either a butcher, baker, carpenter, locksmith, joiner, or mason. The 4 squadrons of the second section are employed in conveying provisions and commissariat stores from place to place, and their companies of workmen make and repair all the waggons and carts that are necessary for that purpose. At the same time, although their employment is of a civil nature, they are regular soldiers, have their own officers, and are properly armed and equipped, the workmen as infantry, the squadrons as cavalry; the uniform is gray, with red trousers, shakos like the other troops, and silver epaulettes for the officers. The badge of the corps is a star, which is on their buttons and accoutrements. The regular commissariat corps is very numerous, and is divided into three distinct branches, each comprising a separate body of officers; the ranks, however, are the same in each branch; they are:—

	Corresponding to
Officers d'administration principaux,...........	Commissary-general.
... comptables, 1st Class, ...	Dep.-com.-gen.
... ... 2d Class, ...	Asst.-com.-gen.
Adjutants *en premier*, ...	Dep.-asst.-com.-gen.
... *en second*, ...	Com.-clerk.

The first section consists of 328 officers of different ranks, and is devoted exclusively to the management of the military hospitals, the medical officers only attending to them professionally. The second section has 78 officers in it, and manages the clothing of the army and the issue of tents and all kinds of camp stores. The third section, consisting of 362 officers, manages the preparing and issuing all kinds of provisions for the whole army. The uniform is nearly the same as that of the medical staff; it is a blue coat without epaulettes, red trousers, and a cocked hat.[1]

The French army is at present recruited partly by voluntary enrolment for a term of years, and partly by requisitions; in other words, on nearly the same principle which obtained before the revolution of 1790. The system of requisition is understood to be subsidiary or supplementary to that of voluntary enlistment, but the war with Russia has made it the principal resource. And this applies to other

[1] *Bulletin des Sciences Militaires*, p. 1850–51–52.

nations as well as to France. Modern manners, customs, habits, and pursuits, are primarily adverse to the military service; and this opposition can only be overcome by a conscription of one kind or other. Napoleon laid it down as a principle, "que la conscription est le mode de recrutement le plus juste, le plus doux, le plus avantageux au peuple."[1] But without being prepared to go this length, it may be admitted that it is equal in its operation; that its results are certain; and that the supplies it furnishes are of the best quality: whilst voluntary enlistment is at best a precarious resource, and sends to the ranks little else than the scum and dregs of the people.

The immense French army now afoot receives its impulse, its administrative direction, and its guarantee of preservation, from a staff admirably organized and composed; a corps of control drawn from the ranks of the army, and distinguished by its integrity, intelligence, and firmness; a health corps as solidly constituted by its excellent organization, as by its superior education and courageous devotion; and various administrative departments equally recruited from the army, and which, owing to their actual origin, their military spirit and good service, had acquired full possession of the esteem and confidence of the whole force.

The national character of every people is commonly developed in a very striking manner by its army. "The Frenchman," says Count Bismark, "courageous, impetuous, nay, even terrible in attack, does not possess that cold-blooded, quiet circumspection and endurance which is so indispensable in a defensive war;" and hence he concludes that a war against the French ought to be carried on *offensively*. "A cautious but not the less uninterrupted offensive must be the ruling principle in all projects of operation against the French."[2] Major Beamish delivers a similar opinion. "The French," says this officer, "have, with much judgment, generally endeavoured to become the *attacking* party. They thus not only derived the usual advantage of that system, but adopted the mode of warfare which was peculiarly suited to their national character. The French soldiers are impetuous; but their courage requires excitement, to which *motion* so much contributes. Abstract motion, however, is not sufficient to impel the French soldier into action—he must be first excited by the example of his officer; and were it not for the extreme and universal gallantry displayed by the officers of the French army, few instances of impetuous courage would be recorded on the part of the men. It has been said that 'the French officers will always lead, if the men will follow;' and there have been instances where the former have nobly sacrificed their lives to produce this effect."[3] General Foy, whose endeavours to depreciate the British are at such variance with the better points of his character, says that "to Frenchmen you must always speak," and that "the intoxication of the French is gay, sparkling, and daring; a foretaste to them of the battle and the victory."[4] A still higher authority confirms these opinions. "Le Français, naturellement brave, actif, et impétueux," says Baron Jomini, "fait aisément des conquêtes, mais il les perd avec la même facilité. Dès qu'il cesse de marcher en avant, une sorte de dégoût s'empare de lui; il est difficile de le contenir. Depuis la révolution, surtout, cette disposition s'était accrue de plus en plus: les liens de la discipline ne retenant plus le soldat, il était devenu mutin, raisonneur, et indocile."[5] Colonel Napier's opinion appears substantially to coincide with that of Jomini and other competent judges.[6] In fact, no military nation of Europe has gained so many splendid victories, and sustained so many disgraceful defeats, as the French; whose whole history, indeed, consists of an extraordinary alternation of the most brilliant successes and the most calamitous reverses, of triumphant ascendancy and abject humiliation. "Aucune nation," says Guibert, "n'a perdu de batailles aussi honteuses, aussi décisives, que la nôtre; aucune n'en a gagné si peu de décisives et de complettes."[7]

Latterly their arms have been distinguished by great success. In the war with Russia, arising out of the attempt of the Czar Nicholas in 1853 to advance his troops upon Constantinople in order to obtain, as he expressed it, a "material guarantee" for the good faith of Turkey towards the followers of the Greek religion—the French sent an army of 80,000 men to co-operate with the British in checking the Russian advances by destroying the stronghold of the emperor in the Black Sea. For years stupendous fortifications had been raising at Sevastopol, the principal harbour and arsenal of Russia in the Euxine. It was evident—even if the conversations of the Emperor Nicholas with certain British functionaries had not disclosed his purposes—that he designed the utter subjugation of Turkey. France and England, equally interested in the preservation of the Ottoman Empire as essential to the balance of power in Europe, held it therefore to be of vital consequence that the formidable means of aggression, perpetually presented in the existence of Sevastopol, should be annihilated. The siege of Sevastopol lasted for eight months. It had been prefaced by a fierce but brief contest on the banks of the River Alma. In this engagement, and in two later ones in the Valley of Inkerman and on the banks of the River Tchernaya, as well as in the attacks upon the Russian outworks and the repulse of numerous sorties, the French army displayed all the fine qualities for which it had, in other times, been remarkable. Finally, it crowned its triumphs by assaulting with great vigour and perfect success the formidable Malakhoff Tower, which was the key to the Russian position. In the skill of the engineers, the excellent and rapid practice of the artillery, the accuracy of the riflemen (the *chasseurs à pied*), the dashing bravery of the Zouaves—originally a corps entirely composed of the natives of the French Algerian provinces—and the energy and professional ability of the generals in command, the strongest proofs are given to the world that a French army had not been rendered, by a long peace, inferior to the other armies of Europe. It was a new and interesting sight to behold such ancient foes as England and France fighting side by side in a good cause; and it is due to both armies to state that their intercourse was as cordial, and their emulation as

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1 Napoleon having established "qu'un million d'âmes fournit chaque année 7000 à 8000 conscrits, et que les besoins de l'administration et des divers états n'en réclamait que moitié," he therefore concluded, "qu'une levée annuelle de 3500 hommes n'offrait, deduction faite des morts, que 30,000 hommes en dix ans," or about a thirty-third part of the entire population. (See Rogniat, *Réponse aux Notes Critiques de Napoleon*. Paris, 1823.) But the draughts on the population of France were never carried to the full extent of the principle, and seldom exceeded 1 in 43 or 44.

2 *Cavalry Tactics*, p. 336, Engl. transl.

3 See Major Beamish's Note to the passage in the *Cavalry Tactics* above quoted.

4 *History of the War in the Peninsula under Napoleon*, vol. i., p. 158, Engl. transl.

5 *Histoire Critique et Militaire des Guerres de la Révolution*, tom. iii., p. 125.

6 Napier, *History of the War in the Peninsula*, vol. i., p. 10. See also vol. iii., p. 329, where, in describing the attack of the British position on the crest of the Sierra de Busaco, 27th September 1810, Colonel Napier renders justice to the "astonishing efforts of valour" on the part of the French, and ably discriminates the respective characteristics of the troops engaged on that occasion. The onset of the French was truly terrible, and at one moment had very nearly succeeded.

7 *Essai Général de Tactique*, tom. i., p. 176.

Army.

noble and generous, as their ancient hostility had been ardent and implacable.

Spanish army.

The Spanish army, which, under Charles V., Pescara, the Duke of Alba, and the Constable of Bourbon, had proved itself so formidable—extending the theatre of its exploits from the Pyrenees to the Po and the Adige on the one hand, and to the Elbe, the Meuse, and the Waal on the other—degenerated rapidly under the disastrous reigns of the last princes of the House of Austria. When Philip V. ascended the throne at the beginning of the last century, it scarcely amounted to 15,000 men. By that prince and his successors, however, it was gradually increased, until, in the year 1792, its establishment amounted to 116,000 infantry, 12,200 cavalry, with upwards of 10,000 artillery, and its effective force to about 120,000 men of all arms. At present it amounts to 99,489 men and 11,395 horses, besides a corps of carabineers for the protection of the frontier. The effective force amounts to 75,000. It is composed of the general active staff, of the staff of the fortresses, of the household troops and royal guard, of the infantry and cavalry of the line, with artillery, engineers, and veterans. Its staff consists of 6 captain-generals, 77 lieutenant-generals, 122 major-generals, 350 brigadier-generals, with inferior officers in proportion. There are 15 captaincies, viz., 12 territorial and 3 colonial. In Spain, and its possessions contiguous to the Peninsula, there are 150 fortresses, posts, forts, citadels, or open towns where troops are in garrison. The household troops consist of six squadrons of the body guard, and a royal corps of halberdiers. The royal guard consists of two divisions of infantry, one division of cavalry, and three companies of artillery, one of which is horse artillery. The first division consists of four regiments of grenadiers, each composed of two battalions, divided into eight companies of 120 men each; and the second of two regiments of the *élite* of the provincial militia, divided into three battalions of four companies each. The cavalry forms a division of two brigades; and the artillery consists of three companies of 100 men, each serving a battery of six pieces mounted. The infantry of the line consists, first, of 10 regiments of three battalions each; secondly, of the Swiss regiment Wimpffen, one battalion only; thirdly, of a regiment, fixed at Ceuta, composed of four companies of 100 men each, the refuse of the army. Seven regiments, of two battalions each, of the same number and composition as those of the line, form the light infantry. The militia consists of 546,286 men, divided into cavalry, infantry, and artillery. The cavalry consists of 13 regiments, of which 5 are of the line, and 8 light horse, each of four squadrons, composed like those of the royal guard; together with two companies of cuirassiers at Ceuta, one formed of native Spaniards, and the other of Moors. The royal corps of artillery is divided into the theoretical and practical. The troops of this arm consist, first, of 6 battalions of foot artillery, in garrison at Barcelona, Carthagena, Seville, Coruña, and Valladolid; secondly, of 4 companies of horse-artillery, in garrison at Carthagena and Seville; thirdly, of 5 companies of artificers; fourthly, of 5 battalions of the train; fifthly, of 3 brigades and 15 companies fixed in garrison, but exclusive of the *personnel* in Cuba and Porto Rico. This arm has a splendid museum at Madrid, besides a theoretical and practical school, directed by a brigadier-general or colonel, in the principal town or place of each province. The engineers are a corps of officers not regimented or brigaded, consisting of an inspector-general, 14 directors, sub-inspectors, 17 colonels, 20 lieutenant-colonels, 34 captains, and 56 lieutenants; together with a regiment of sappers, consisting of 2 battalions of 8 companies each, viz., 5 of sappers, 1 of miners, 1 of pontonniers, and 1 of workmen. The establishments of this arm are, a topographical depôt-general, or collection of maps, plans, and military memoirs; a museum containing representations in relief of the fortresses, and different models of fortification; and an academy for the instruction of young officers intending to enter this branch of the service, after they have passed through the primary school of Segovia. All these establishments are situated in the capital. A body of 10,499 men compose the gendarmeries, and there is a company of militia in the Canaries.

The Spanish army is recruited by voluntary enrolment, and, in case of insufficiency, by ballot or conscription. The term of service is eight years for the first enrolment or ballot, and two or four for the second, when the soldier becomes entitled to an increase of pay. Before the war of independence no one could attain the rank of officer without having been a cadet; and each cadet was bound to prove his nobility. But after the return of Ferdinand these proofs were dispensed with, and sergeants now obtain a third of the sub-lieutenancies—the other two-thirds being reserved for the pupils of the military school of Segovia, who have passed the customary examinations at the end of their course of study. The dress and equipment of the Spanish army are in the worst state; the pay of the troops is exceedingly irregular; and their discipline is, in consequence, as bad as it is possible to imagine, or rather, there is scarcely such a thing known.[1] "L'Espagnol, sobre, vigoureux, infatigable," says Jomini, "possède de grandes vertus guerrières, mais il manque d'activité soutenue. Si dans ces dernières révolutions, son caractère se soumit difficilement à la discipline, nous avons été induit à penser, en observant l'esprit du peuple, que dans les temps ordinaires, il y serait plus facilement ployé. Son courage tumultueux prêtait beaucoup à une prompte désorganisation, car la déroute est toujours compagne de cette disposition naturelle des esprits chez les peuples méridionaux."[2]

During the war in the Peninsula in 1809–14, Wellington experienced a great deal of trouble from the impossibility of relying upon the steadiness of the Spanish troops, and the good spirit of their leaders. At the battle of Talavera the British leader found it necessary to place his 34,000 Spanish allies where their firmness would be exposed to the slightest test; but even this precaution was unavailing. Five thousand Spaniards decamped immediately after the order of battle had been formed! Yet their generals claimed for them the honour of the victory—the chief of them being a senile dotard, who had stipulated for all the consequence of command without the responsibility. Since that time there has been little or no evidence of an improvement either in the composition of the troops or the character of their leaders. In a word, the Spaniards afford a striking illustration of the truth of Napoleon's maxim, that *in war the moral is to the physical force as three parts to one.*

Portuguese army.

After the general peace of 1814, when all the powers of Europe had reduced their military establishment, Portugal alone did not follow their example, but fixed the peace establishment of its permanent army at 49,268 infantry and 5230 cavalry; which, with the militia, made a force of 59,325 men, or about 22 soldiers for every 100 inhabitants. Such a state of things, however, was much too violent to be durable. Accordingly, one of the first cares of the constitutional go-

[1] *Notice sur l'Armée Espagnole,* redigée sur *El Estado Militar* de 1828 et sur un manuscrit. Paris, 1829. *Bulletin des Sciences Militaires,* tom. v., p. 420. With regard to the present state of discipline, or rather of indiscipline, of the Spanish army, the author of the *Notice* observes, "La discipline n'a jamais subsisté dans l'armée Espagnole. Ce n'est pas qu'il manque de réglement; il en existe un fort étendu, redigé avec soin d'après le nôtre (le Français) de 1792; mais c'est un frein qu'on n'a pu jusqu'ici amener l'Espagnol à supporter. Au respect près que le soldat a pour son officier, il n'y a pas l'ombre de discipline."

[2] *Histoire Critique et Militaire des Guerres de la Révolution,* tom. i., p. 242.

Army.

vernment of 1821 was to reform a military system so disproportionate to the population and the financial resources of the kingdom. The armed force since that period has therefore consisted exclusively of the permanent army and the militia. The permanent army is composed of a general staff, an engineer corps, 18 infantry regiments of the line of 9 companies each, 9 battalions of *chasseurs-à-pied* and 6 regiments of *chasseurs-à-cheval*, 3 regiments of artillery, a battalion of engineer artificers, a company of soldiers of the train, a municipal guard, and 30 companies of veterans. The general staff consists of 1 marshal-general, 2 marshals of the army, 10 lieutenant-generals, 16 major-generals, 15 brigadier-generals, 6 superior officers, 6 subalterns, 12 aides-de-camp, 12 secretaries, 10 employés, and a surgeon-in-chief. The engineer corps (*corpo de engenheiros*) is composed of 4 colonels, 4 lieutenant-colonels, 8 majors, 12 captains, 12 lieutenants of the first class, and 12 of the second; in all 64. Each regiment of infantry of the line and of light troops consist of 44 officers and 780 non-commissioned officers and soldiers. The effective strength of a regiment of artillery is 551 men, including 45 officers. The corps of the train of artillery (*artilheros conductores*), reduced to a single company by the organization of 1821, is composed of 12 officers, 30 soldiers, and 70 mules (*bestas muares*). The battalion of engineer artificers consists of 263 men, including 65 officers. Each of the 30 companies of veterans is from 70 to 80 strong, including 2 officers. The municipal guard of Lisbon consists of 1766 men, including officers; together with a battalion of *gens d'armerie à cheval* 238 strong, divided into 4 companies. The effective force of the permanent army on the peace establishment is therefore about 26,000 foot and 2000 horse—18,000 foot are in active service, 4600 in Africa, and 4400 in the Portuguese settlements in Asia. But there is a local force in the islands and colonies amounting to 28,000 men.[1] The *ordinenzas*, which formed 441 legions or *capitanea mores*, were abolished by the Cortez in 1822, to the great satisfaction of the nation, which justly regarded this institution as a most grievous scourge. They were a sort of levy *en masse*, which all individuals between the age of 16 and 60, unless serving in the regular army or in the militia, might be called upon to join at the shortest notice. The army, which is indebted for its organization to Marshal Beresford, is well disciplined and instructed. Its equipment and arms are the same with those of the English troops.[2]

Austrian army.

At the period when the Emperor of Germany engaged in war with revolutionary France, the Austrian army was on a very effective footing, both in regard to organization and numbers. The infantry, it is true, though well trained and disciplined, wanted vivacity, and its physical was superior to its moral force. But the cavalry, which was composed of admirable materials, rivalled the Prussian squadrons in instruction, and surpassed them in other particulars. The artillery and engineers were also good, although the *matériel*, less perfect than that of the French, was either too heavy for pieces in position, or too light for efficient service in the field. Nor was the staff deficient either in erudition or in talents; but its theories were antiquated and vague, resting partly upon the system of cordons attributed to Lascy, and partly also upon certain hypotheses, which it was gravely proposed to put to the test of experiment in the field. At the commencement of the war with France, the imperial army consisted of 232 battalions of infantry and 220 squadrons of cavalry; and as the battalions were very strong, being raised by means of reserves to 1200 men and upwards each, the whole of the Austrian force at this period may be estimated at 240,000 foot, 35,000 horse, and 10,000 artillery.[3] But the reverses it experienced in consequence of an obstinate adherence to a vicious system, and the exigencies of the long and protracted struggle with republican and imperial France, led to successive augmentations of the effective force, until at one time it considerably exceeded 700,000 men of all arms. At the general peace of 1814, however, Austria, exhausted by a war of five-and-twenty years, reduced her military establishments nearly one-half; adjusting the scale of peace so as to render it commensurate with that which, it was conceived, France would adopt as soon as the Bourbons felt themselves in a condition to re-organize a permanent force. Several changes have since been made, the most important of which have taken place in the past eight years, arising out of the disturbed state of the eastern part of the continent of Europe; but the account which follows, derived from the most authentic sources,[4] will be found to exhibit a correct view of the actual force and organization of the Austrian army, consisting of the troops of the line, and the *militär-gränzen*, or *military of the frontiers*.

The *infantry*, exclusive of the 14 regiments of the frontiers, is composed of 62 regiments of the line, 1 regiment of chasseurs; besides, in time of war, the infantry of the staff and the landwehr. Of these, 3 are recruited in Lower and 2 in Upper Austria, 5 in the interior and in the Illyrian provinces, 9 in Bohemia, 5 in Moravia, 11 in Galizia, 4 in the Venetian States, 4 in Lombardy, 12 in Hungary, and 3 in Transylvania. The different regiments are designated respectively by the names of their provinces, and those of the officers who are proprietors therein (*inhaber*). A regiment of the line consists, in time of peace, of 1 colonel, 1 lieutenant-colonel, 3 majors, 21 captains, 73 subalterns—in all 99 officers, not including 5 staff-officers, 2 grenadier and 16 light infantry companies, containing 3318 men. The companies of grenadiers form separate battalions, commonly consisting of three divisions or six companies. The Hungarian and Transylvanian regiments consist, in time of war, of 4 battalions of 6 companies each; and the company contains 200 men. The force of the infantry of the line amounts, therefore, on the peace establishment, to 1984 companies, or 372 battalions, making a total of 425,878 men during war. By the *military frontiers* are understood the provinces and districts conterminous with Turkey, to the east and south of the empire; which, by reason of the military service, internal as well as external, that their male population is subject to, have an organization entirely military, some districts of Transylvania alone excepted. These military provinces furnish 14 regiments of national infantry, a battalion of *tschaikists* or watermen of the Danube, and a regiment of hussars (*szekler*), who, inasmuch as they are liable to be called to join the army, really form part of it, but who, in respect of their particular organization, may be considered, in time of peace, as constituting a distinct force. Military Croatia comprehends six districts, each of them furnishing a regiment, which bears the name of the chief place of the district, and consists of 12 companies. The service of these regiments in time of peace is confined to guarding the cordon. Similar service is rendered by the regiment of gens-d'armes in Lombardy, and the military cordon in Galizia. The light infantry is composed of the

Army.

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1 *Almanach de Gotha*, 1856.

2 *Notice sur l'Armée Portugaise*, extrait analytique de *l'Essai Statistique sur le Royaume de Portugal et d'Algarve*, par Adrien Balbi. Paris, 1827. *Bulletin des Sciences Militaires*, tom. iv., p. 121.

3 Jomini, *Guerres de la Révolution*, tom. i., p. 232.

4 The account of the Austrian army, given in the text, is derived partly from the *Allgemeine Militär-Zeitung*, which appeared at Leipzig and at Darmstadt in 1826, partly from the *Constitution de l'Armée Austrichienne* of Bergmayr, partly from the *Annuaire Militaire Austrichien*, and partly from Mr Edward Thompson's "Austria," published in 1849, together with a variety of papers in the *Bulletin des Sciences Militaires*, and the *Almanach de Gotha* of 1856.

imperial regiment of Tyrolese riflemen, consisting of 4 battalions of 4 companies each; 12 battalions of chasseurs, 4 companies each in time of peace, and 6, with a depôt company, in time of war; 17 national frontier infantry regiments, and 1 Illyrian Banatisch battalion. A company of chasseurs consists of 195 men, including officers. The garrison battalions, composed of a sort of demi-invalids, unfit for the service of the line, are stationed, 1 in Buckowina, 1 in Esclavonia, 1 in Hungary, 1 in Dalmatia, and 1 in Lombardy, and consist each of six companies, with the same complement of officers and non-commissioned officers as the companies of the line. The divisions of infantry of the staff (*stabs-infanterie-division*), are composed in the same manner; and organized, in time of war, for the purpose of guarding the headquarters and the magazines of the army, and of removing the wounded from the field of battle to the nearest hospitals. The number of battalions of the landwehr is seventy. In each district of country (Hungary, Transylvania, and Italy excepted) assigned for the recruitment of a regiment, two battalions of landwehr are raised and attached to such regiment; the one containing the men who are the least necessary to their families, and the most proper for the service, and the other, the surplus of those who are obliged to form part of the landwehr. The first battalion is exercised fifteen days in the year, the second only eight hours. The commandants receive their orders from the colonel of the regiment of the line to which their battalions are respectively attached. The landwehr is principally destined for the service of the interior; but it may also be sent to an active army. In either case it is paid the same as the troops of the line.

The *cavalry* consists of 8 regiments of cuirassiers, 8 of dragoons, 12 of hussars (exclusive of the frontier regiment), and 12 of hulans; together with, in time of war, the dragoons of the staff (*stabs-dragonner*); all raised, like the infantry, in different provinces, viz., 3 regiments of cuirassiers in Bohemia; 3 in Moravia, 1 in Lower Austria, and 1 in Central Austria; 3 regiments of dragoons in Moravia, 1 in Upper and Lower Austria, and 1 in Lower and Central Austria; 1 regiment of light horse in Moravia, 4 in Bohemia, 1 in Galizia, and 1 in Italy. The hussars of the 12 regiments are all either Hungarians or Transylvanians. The regiments of hulans consist of inhabitants of Galizia and volunteers. In time of peace, the regiments of cuirassiers and dragoons consist of 6 squadrons, and the other regiments of 8; making in all 260 squadrons. Two squadrons make a division; and in regiments which have 8 squadrons or 4 divisions, 2 are commanded by the majors. The dragoons of the staff, of which there are several divisions in time of war, have the same destination as the infantry attached to it, and are besides employed in repressing disorders committed by marauders, and in other like services.[1]

The *artillery* is divided into three parts, or distinct corps, viz., the field artillery (*feld artillerie*); the artillery of the arsenals and magazines (*feld zeugamt*); and garrison artillery (*garnison artillerie*). The *field artillery* consists of 168 batteries, or 3898 men and officers. It is recruited by corporals of artillery, and performs the most difficult as well as important service to the army. A regiment of field artillery is composed of a staff and 4 battalions, one of 6 companies, and three others of 4 companies each; making in all 18 companies. A company serves three or four batteries of 6 pieces; and each battery is commanded by a lieutenant or major-firemaster. The train of the army furnishes the horsing of the batteries, which is under the command of officers of that corps, and generally independent of the chiefs of batteries, but subordinate to them in this particular service. The rocket corps is established at Neustadt, near Vienna, where it has for some years been occupied in fabricating Congreve rockets, we believe with considerable success. The *artillery of the arsenals and magazines*, consisting of a staff and *personnel* of the necessary workmen, furnishes the field artillery, and the equipages of war, with the requisite arms and munitions, and it guards them when in magazine. The *garrison artillery*, charged with the service in fortresses, is divided into fourteen districts, determined by the provinces, and proportioned in numbers to these districts. Its total strength is 7400 men and officers. The district of garrison artillery of Vienna comprehends an arsenal, containing all the equipage of sieges; and attached to it are a foundry, an establishment for boring cannon, and manufactories of saltpetre and gunpowder.

The *engineer department* comprehends a corps of engineers, with the sappers and miners. The pontoon train is attached to the staff, and is under the direction of an *oberstschiffamt* or chief of boats. The train of corps of military equipages (*militär-fuhrwesens-corps*) is wholly independent. The engineer corps is composed of 4 generals, 6 colonels, 9 lieutenant-colonels, 18 majors, 42 captains, 30 captains *en second*, 30 lieutenants, 30 sub-lieutenants, 12 cadets, and 5000 men. Each command of military division embraces a district of fortification; consequently there are fourteen such districts, to each of which is attached a director, who is taken from the generals or officers of the engineer staff. In each place there is also an engineer-in-chief, who is an officer of the staff or a captain of engineers; but in Vienna, Milan, Peterwaradin, and Venice, the director performs the functions of chief engineer. The corps of miners is composed of a staff, five companies, and a garrison detachment; and the corps of sappers, of a staff like that of the miners, six companies, and a garrison detachment. The pontoon corps consists of a staff and 2 battalions of 4 companies each. In time of war the number of battalions is three, two of which have 6 companies and one 4; besides a company in depôt. The train or corps of military equipages consists, in time of peace, of 12 divisions of transport (*transports-division*), and 20 sets of horses for field batteries (*exercier-batterie-bespannung*). Each division is provided with 90 horses; and all the detachments of the corps stationed in a province are under the orders of a commandant. In time of war the military equipage train consists of seven principal divisions, viz.,—1. the artillery transport division; 2. that of pontoons; 3. that of flying bridges; 4. that of baking; 5. that of health for the transport of the wounded; 6. that of victualling; and, 7. that of general transport.

Two regiments of the same or different arms form a brigade, which is under the orders of a major-general; and two or three brigades form a division, which is commanded by a field-marshal-lieutenant. In time of war, corps-d'armée are organized, each consisting of several divisions, and under the orders of a general of cavalry or artillery, or of the oldest field-marshal-lieutenant. In the Austrian army there are at present 6 field-marshals, 23 generals of cavalry and ar-

[1] Jomini has particularly remarked the superior composition, organization, and discipline of the Austrian cavalry, which has proved its excellence in many bloody encounters, and, when led with talent, has never failed to distinguish itself. At the battle of Würtzburg, 3d September 1796, Wartensleben passed the Maine with twenty-four squadrons of cuirassiers, attacked the French cavalry under Bonneau, overthrew it, and thus decided the victory. "This brave veteran," says the Archduke Charles, "impressed with the importance of the order which he had received, dashed into the Maine at the head of his cavalry, and swam across." "This manœuvre," he adds, "was completely successful: the French cavalry, which had awaited the charge without stirring, was overthrown." At the battle of Leipzig, the Austrian cuirassiers, commanded by Nostitz, "covered themselves with glory." On the 16th October, at one o'clock in the afternoon, Nostitz, having scarcely passed the Pleisse at Gröbern, attacked the lancers and dragoons of the French imperial guard, overthrew them, and then broke several squares of infantry. Other instances of a similar kind might be mentioned.

tillery, 116 field-marshal-lieutenants, and 164 major-generals, in actual service; 9 generals of cavalry and artillery, 30 field-marshal-lieutenants, and 92 major-generals, unemployed. The guards form no part of the army. They are divided into the German guard, the noble Italian guard, the gardes du corps, and the gendarmerie of the guard. The military institutions of the first order consist of the company of cadets at Olmütz, that of Gratz, the military academy for cadets at Vienna, the five regimental schools of artillery, the school of bombardiers, and the academy of engineers. The total of the peace establishment of this army is 315,000 infantry and 50,000 cavalry, with a reserve of 250,000; while its war establishment amounts to 521,000 infantry, 131,000 cavalry, and 60,000 artillery.

Prussian army.

At the death of Frederick the Great, the army of the Prussian monarchy, amounting to about 200,000 combatants, was accounted the best in Europe. Proud of a struggle without example in modern annals, and of the superiority of the genius of their king, the victors of Leuthen, Rosbach, and Torgau added to this force of opinion an instruction in great manœuvres, which the troops of no other nation approached, much less rivalled.[1] The successor of Frederick, to whom this superb army descended, though possessed neither of his genius nor his ambition, was at great pains to maintain the reputation which it had acquired; and some laurels that had been easily gathered in the Low Countries seem to have inspired him with the notion that it was still capable of equalling, perhaps surpassing, the brilliant achievements which had established its renown. In this spirit, and, doubtless, believing that the French nation might be reduced with the same facility as the insurrection in Holland, the Prussian monarch put himself at the head of the confederacy formed to crush a people who had risen in arms to assert their liberties and preserve the integrity of their territory. But the issue proved how much he was at fault in his calculation. For a mercenary and mechanical army, however perfect its discipline and instruction may be, can never triumph over a generous people, inspired by patriotism, endowed with high military qualities, and resolved to conquer or to die in defence of their liberties. Besides, the Prussian army of this period[2] was not a national one, nor was it animated by a common feeling. The half of it, as at Frederick's death, was still composed of deserters from all nations, or volunteers enlisted in every circle of the empire;[3] it was neither inspired by the genius of its chief, nor excited by any feeling calculated to improve its moral force; discipline formed the only tie by which it was held together. Nor was it long ere its inferiority was proved; and its pride severely humbled. The affair of Valmy opened the king's eyes; and henceforth, more docile to the suggestions of prudence, he negotiated for permission to withdraw to the right bank of the Rhine the wrecks of that army, the glory of which had just been eclipsed in the plains of Champagne by battalions of youthful volunteers. He had been taught a lesson, by which he did not fail to profit; and after the unsuccessful campaigns on the Rhine, he crept ingloriously out of the contest which he had been so eager to commence; leaving the empire and Austria to the undivided resentment of the conquerors. But he re-established his army, while his late ally was maintaining a death-struggle. The parades and manœuvres of Potzdam were resumed with their wonted éclat; confidence revived; and Frederick began to flatter himself that he alone could re-adjust the disturbed equilibrium of Europe. He failed, however, to observe the prodigious development which the military art had received in the course of the revolutionary war, or at least he neglected to profit by the discoveries to which it had given birth; and, as he had formerly deserted his ally at the beginning of the contest, so now he took the field just at the moment when that same ally was being overthrown at Austerlitz, and compelled to accept the terms dictated by the conqueror. And at Jena as at Auerstadt, at Halle as at Lubec, he paid the price of his procrastinating folly. But misfortune, a rough schoolmistress, had inculcated some useful lessons. The military constitution of Prussia was changed; foreign recruitment ceased; a national army was formed; the privileges of the nobles were abridged; old institutions were reformed; discipline was improved by being simplified; the arming and equipment of the army were improved in all their branches; the best parts of the French military system were adopted; the patriotism of the nation was roused; in short, during five years, Prussia was silently but actively employed in preparing those elements of strength which, in 1812, delivered the monarchy from the yoke of the stranger, and re-established her at the head of the second-rate powers of Europe.

The armed force of the Prussian monarchy is composed, first, of a permanent army; secondly, of a war reserve, or *landwehr*, in two bans; thirdly, of a *landsturm*, or sedentary national guard. The permanent army is composed of young men of family who are destined to the profession of arms, and are named officers after undergoing certain examinations; of volunteers, who clothe, equip, and support themselves for a year at their own charge; of persons between the ages of 17 and 40, who enlist voluntarily, and receive regular pay; of a part of the youth from 20 to 25 years of age, raised by means of requisition; and, lastly, of veterans or soldiers who consent to remain in the service beyond the term prescribed by the law. The regular *infantry* consists of 63 regiments of 144 battalions; the *cavalry* of 38 regiments of 4 squadrons each, 10 of which are cuirassiers, 5 dragoons, 13 hussars, and 10 hulans—in all 158 squadrons;[4] the *artillery* of 24 brigades, each consisting of 2 batteries, 8 field pieces; and the *gens-d'armerie*, of 8 brigades, divided each into 2 detachments.[5] All the youth who have not served five years in the active army or in the reserve, form part of the *first* ban of the *landwehr*, until they attain the age of 30 years complete. The *second* embraces those from 32 to 40 years of age; and both classes, during time of peace, remain at home, pursuing their ordinary avocations. But, in the event of war, the first ban is destined to reinforce the permanent army; and the second to form the garrisons of strong places, and even, in case of need, to send detachments to the army in the field. The *landwehr*,

[1] *Guerres de la Révolution*, tom. i., p. 228. Notice sur le Système Militaire de la Prusse, *Bullet. des Scien. Milit.*, tom. iii., p. 417, 461, 541, et tom. v., p. 417. See also *Archiv für neuere Kriegs und Armée Geschichte*, vol. i., part 1st; and *Zeitschr. für Kunst, Wissenchaft, und Geschichte des Krieges*, part 2d, 1817.

[2] At the commencement of the French Revolution the Prussian army consisted of about 120,000 infantry, 35,000 cavalry, and from 7000 to 8000 artillery, with a most respectable corps of engineers. (*Guerres de la Révolution*, i. 232.) In 1806, it amounted to 260,000 men of all arms. (*Etat Comparatif de l'Armée Prussienne en* 1806 *et en* 1827. *Bullet. des Scien. Milit.*, tom. v., p. 417.)

[3] Jomini reckons the number of foreigners serving in the Prussian army at this period at only *a third part* of its entire strength; but we agree with the author of the *Notice sur le Système Militaire de la Prusse* in thinking it amounted to a half. The data on which this conclusion is founded appear amply to warrant the statement made in the text. (*Hist. Crit. et Milit.* i. 233.)

[4] The Prussian cavalry, in the time of Frederick, was confessedly the best in Europe. "L'infanterie Prussienne," says Jomini, "quoique manœuvrière était cependant loin d'atteindre le degré de perfection auquel Seidlitz avait porté le cavalerie: cette dernière arme tenait alors le premier rang en Europe." (*Hist. Crit. et Milit.* i. 231. See also *Cavalry Lectures*, p. 329.)

[5] The gens-d'armerie is of three kinds: the *armée gens-d'armerie*, divided into detachments stationed at the headquarters of generals of corps-d'armée; the *land gens-d'armerie*, consisting of 80 wachtmeister and 1240 gens-d'armes, of whom 1080 are mounted; and the *granz-gens-d'armerie*, which assists the employés of the customs in discharging their duties on the frontiers.

Army. like the permanent army, is composed of infantry, cavalry, and artillery. In the year 1827 the infantry of the first ban consisted of 116 battalions, and the cavalry of 104 squadrons. Hence, if we include 54 garrison companies, and 18 of invalids at Berlin, Stolpen, and Rybnik, the total of the peace establishment of the Prussian army will amount to 122,000 men, while that of war would not be less than 250,000 men of all arms; and such is the admirable military organization of the country, that two months only are necessary to raise the army to the full complement of the war establishment. In Prussia the cavalry is a preponderating arm. Of the 122,000 men composing the peace establishment, 37,000 belong to this branch of the service. The *landsturm* is a levy *en masse* of men from the age of 17 to that of 50; and in cases of imminent danger it is called out by a royal ordonnance. It is formed into urban and rural companies, and, like the French national guard, performs, if necessary, the duties of the interior; thus leaving the whole of the permanent army and the *landwehr* available for the service of the field. The actual constitution of the Prussian army is strictly economical in all its parts, and the number of military functionaries is reduced to the lowest possible scale consistent with the efficiency of the service. In Prussia every man who wears a uniform works hard for his money.

All Prussians, from the age of 20 to 50, are held liable to military service, but they only serve regularly from 20 to 26. The duration of service is consequently fixed at five years; but, in time of peace, the requisitionary youth remain only the first three years under their colours, after which they return to their homes, and are not called out again, except for a few weeks towards the expiry of the fifth year, when they are inscribed in the *landwehr* of the first ban. The population of Prussia being 11,500,000 souls, about 98,000 males will annually attain the twentieth year of their age. Hence, if we deduct 38,000 for such as are excepted from military service on account of their age or their status in society, the total number of disposable persons, between the age of 20 and 25, will amount to 395,000. And if to this we add that portion of the male population from 25 to 32 years of age who are eventually called to the service, it will follow that Prussia, without having recourse to the second ban of the *landwehr*, could raise 900,000 men trained to the use of arms; while France, even since 1824, when the re-organization of her army commenced, could scarcely bring into the field more than 480,000 men, of which the one-half would be nearly uninstructed in the use of arms. The annual renewal of this army by thirds renders it necessary to push, with the utmost activity, the instruction of both infantry and cavalry, and to pay little regard to that martinet precision which formerly characterized the Prussian tactics, but which is of so small use in the presence of an enemy. The showy on parade has consequently been sacrificed to the useful in the field; and the mere foppery of war has given place to movements and evolutions, which are recommended alike by their simplicity, and by the testimony which experience (the best of all instructors) has borne in their favour. So long ago as the year 1808, the degrading discipline, introduced by the father of Frederick the Great, was abolished by the *kriegs-artikel* or the martial law; and military punishments are now principally confined to hard drills, confinement of various degrees, retrogradation in rank, and some others of a still milder description. Finally, the first grades are the reward of merit established by examination, and as such open to all; while, from the rank of sub-lieutenant to that of general, and even beyond it, seniority (that conservative law of acquired rights) regulates the advancement of officers, and ultimately insures the veteran his reward. Thus, after sustaining the greatest disasters, the Prussian army has survived its dispersion in 1807, and risen, as it were out of its ashes, stronger and better constituted than at the period when it was so rashly opposed to the undivided power of France, wielded by the master-hand of the greatest warrior of modern times. "Heureux les gouvernemens," says a French military writer, "auxquels les malheurs servent de leçons!" Nor would their "happiness" have been much diminished had such governments remembered in victory the promises made to the people in misfortune, and shown but half as much zeal to improve *their* condition as to rectify the defects of their military systems.

Russian army. At the period of the Emperor Alexander's death, the distribution of the Russian and Polish forces was that of an army ranged in order of battle, with its front facing the west. 1. The advanced guard of this army was formed by the Polish army and the corps d'armée of Lithuania; presenting a mass of 80,000 combatants, under the command of the Grand Duke Constantine. In point of mechanical instruction, no army in Europe could be compared to it. Disposed in cantonments of about 150 leagues in length, from Lowicz to Minsk, and 146 in breadth, between Kowno and Dubno, it could be concentrated, at Warsaw or at Brzecs-Littowsky, in less than three weeks. 2. The army of the right was composed of the corps d'armée cantoned in Courland and Livonia, of the corps of the guard, and of the first corps of the cavalry of reserve; which, united, formed also a mass of 80,000 combatants. These were perhaps the only troops which, in point of mechanical perfection, rivalled the army of the advanced guard under Constantine. Their cantonments extended from Polangen to Pleskof, about 132 leagues, and from Revel to Wilkomirsz; and eighteen days at the most were sufficient for assembling them on the Niemen. 3. The army of the left, denominated the second army, was equally formed of a mass of 80,000 combatants, cantoned in the Chersonesian governments. The greatest depth of its quarters, from Choczym on the Pruth to Czerkasy on the Dnieper, was about 106 leagues; and the greatest breadth 180 leagues, between Machnowka, near the southern frontier of Volhynia and Simpherapol in the Crimea. Three weeks were necessary for concentrating it on the Pruth. 4. The army of the centre, called also the first or grand army, forming a mass equal to the three preceding armies, and consequently consisted of 240,000 combatants. Its cantonments extended on one side to more than 234 leagues, or from Kaszin, on the frontier of the government of Tver and of Jaroslaf, as far as Saratow; and, on the other, to upwards of 320 leagues, from Ostrog to Moroum, on the frontier of the government of Vladimir and of Nijnei-Novgorod. It required six weeks at least for concentrating itself in the province of Volhynia. 5. Besides these four armies, consisting of 480,000 men, Russia had also several corps, of various descriptions, amounting to more than 267,000 men; viz., the corps of Finland, of Orenburg, and of Siberia, 45,000 strong; the corps of the Caucasus, 85,000; the military colonies, 67,000; and the troops in garrison, 70,000; thus making a grand total of 747,000 men, exclusive of the Kirgishes, Baschkirs, and other Tartar hordes, of whom from 250,000 to 300,000 may in case of exigency be brought into the field. The whole military force of the Russian empire, at this period, may, therefore, be estimated at above a million of men, or a forty-ninth part of the entire population; while the country, as we have just seen, was organized into one vast camp, arranged upon strategic principles, so as to render the transition from a state of peace to a state of war easy and expeditious, and, with formidable means of aggression, to combine defensive resources of almost incalculable extent.[1]

The contest with Turkey in 1828 and 1829, and Poland

[1] *Etat des Armées Russes et Polonnaises à l'époque de la mort de l'Empereur Alexandre, ou comparaison entre ces deux armées et les autres puissances armées de l'Europe.* Paris, 1826. Mauvillon, *Militär Blätter* for 1826, part 1st. *Bulletin des Scien. Milit.*, tom. iii., p. 385.

in 1830, produced no sensible derangement of this system, and only altered for a time the relative proportions in the numbers of the four principal armies, according as troops were moved upon the various strategic points in the theatre of war. But the *lacunæ* created by the casualties of campaigns in Moldavia, Bulgaria, Rumelia, and Circassia were soon filled up; and, consequently, the above account of the military organization and force of the Russian empire was as applicable in 1853 as it was from the death of Alexander in 1826 to the commencement of the Turkish war in 1828. The Russian army, at different periods of the campaign of 1828, never had more than 88,000 men in its first line;[1] a force which was not calculated, certainly, to excite any very great degree of alarm in the minds of other nations. M. Tolstoy, it is true, alleged that political reasons prevented the employment of a greater force; and that if the Russians only brought forward 88,000 men in the first campaign, "c'était qu'ils ne voulaient point effrayer l'Europe et réveiller des jalousies qui sommeillaient." But closer observers saw reason to believe that the real cause why the campaign was undertaken with a force comparatively so small, did not consist in any particular respect for the "slumbering jealousies" of other nations, but in the supposed inability of Russia to take the field with a larger army; that her physical means are out of all proportion greater than her financial resources or power of developing them in a foreign war; and that however formidable or invincible she might prove to an enemy invading her own territory, a long period must yet elapse before she could be in a condition to occasion any serious uneasiness to the nations of the south and west of Europe. Even in the campaign of 1829, when so many losses were to be repaired, and the reputation of the Russian arms, if possible, to be freed from the tarnish they had contracted in the course of the preceding one, Count Diebitsch was compelled to attempt the passage of the Balkan with no more than 30,000 men; and, in point of fact, he appears to have arrived at Adrianople in the month of October with less than the third of that small force; a miracle of fortune, certainly, but, at the same time, a conclusive proof of the exhausted state of the Russian finances, and of the inability of the Czar to carry on a distant and protracted war. Diebitsch owed his success to two causes—the powerful cooperation of the fleet, and the despairing fatalism, or rather infatuation, of the Turks. But the fortunate result of the enterprise did not blind the world as to the circumstances under which it was undertaken, nor conceal the weakness which preternatural folly, on the part of the Osmanlis, at length gilded with victory.

Nevertheless, in 1853 (a lapse of 24 years), the Emperor Nicholas, after a series of aggressions which extended the Russian dominion S. of the Caucasus into Georgia and Mingrelia, came to the conclusion that the Ottoman Empire was reduced—by misgovernment, internal intrigues, and the hostility engendered among the orthodox Mussulmans, by the reform of the Sultan Medjedi—to a state of feebleness compared to that of "a sick man;" and that, therefore, it would fall an easy prey to Russia. Accordingly, upon the breaking out of a quarrel between the Greek and Latin Christians in the Holy Land, and the determination of the Porte to act with impartiality in the dispute, the Emperor of Russia, as has already been stated when treating of the French army, stepped in, and, assuming the character of the head and protecter of the Greek Church, claimed preferences for the Greeks. These the Porte refused to recognise. Hereupon the Czar marched an army across the Pruth towards the Danube. The Turks flew to arms, and gallantly opposed the Russian armies, defeating them at Oltenitza, Giurgevo, and Kalafat, and compelled them to raise the siege of Silistria. But it was evident that, single-handed, Turkey could not stand long against Russia. The fate of Constantinople, and, consequently, of the balance of power in Europe, raised general apprehension. It became evident that to prevent the Mediterranean from becoming, like the Black Sea, a Russian lake, a formidable alliance of the Western Powers was indispensable. France and England, estranged for centuries, accordingly became fast friends. Sardinia joined them; and each contributing a quota of ships and troops, the fleets and armies of the combined powers attacked Russia in the Baltic and the Black Sea, destroying some of her strongholds, and compelling the annihilation of the men-of-war which floated in the harbour of Sevastopol, and the fortified town and arsenal of Sevastopol itself. Even while we write the war continues; and Russia having put forth all her energies to continue the defence of her possessions, viz., the Crimea and the Baltic, her military force now stands at the present rate:—

The Great Mobile (or *Moveable*) *European Army*.—The imperial guard—12 regiments of infantry, of 3 battalions each, containing 1000 men; 7000 life-guards—making a total of 40,000 infantry, 3840 light cavalry, and 120 guns stationed at Warsaw.

The Grenadier Corps, containing 12 regiments, of 4 battalions each, or 48,000 men; 1000 sappers, 1 brigade of hussars, and 1 brigade of hulans, making 5120 men; 1 division of foot artillery with 120 guns, and a brigade of horse artillery with 16 guns, stationed at Novgorod.

The Infantry Corps.—288 battalions, of 1000 men each; 6 battalions of sappers, 1000 men each; 6 divisions of light cavalry, comprehending 192 squadrons = 30,720 men; 6 divisions of foot artillery with 90 batteries, and six brigades of horse artillery with 12 batteries. All these are echelloned in a semicircle round the frontiers of the Russian empire, beginning at the Baltic provinces, then passing through Poland and Bessarabia, and along the shores of the Black Sea and the Sea of Azoff, up round to Moscow.

The Great Cavalry Reserve, in these parts, comprehend cuirassiers, light cavalry, dragoons, hulans, hussars, mounted pioneers and mounted batteries, to the number of 40,000 sabres and 128 guns. Thus the great army consists of 386 battalions of infantry, or 386,000 men; 469 squadrons of cavalry, or 79,720 sabres; and 100 batteries of artillery, or 1200 guns—say, with artillerymen, miners, sappers, &c., half a million men.

The European Army of Reserve remains, as in 1842, at 182 battalions, or 182,000 men; 128 squadrons of cavalry, or 20,480 men; and 472 guns.

The Caucasian Army numbers 81,167 men of all arms—that of Trans-Caucasia 80,000. 16 battalions and 1 brigade of artillery compose the Finland army corps; 16 battalions, 1 brigade of artillery, and 16 regiments of Cossacks of the Ural, form the army corps of Orenburg. The Siberian army corps consists of 16 battalions and 1 brigade of artillery. The various corps of Cossacks number 50,000 men. A great war reserve is forming by a most extensive levy; and there are 60,000 veterans and invalids in the empire.

The system of recruiting in Russia is exceedingly autocratical. When new levies are wanted, orders are issued to the headmen of villages; each of which is required to furnish a certain number, according to the amount of its population. The selection is made by the headman, who is perfectly absolute in the matter; and Jews are now obliged either to serve or pay for substitutes, who are not easily procured in a country like Russia, where so few of the lower class are their own masters. Formerly it was very difficult

[1] *Replique à la Réponse de M. Magnier aux Observations d'un officier d'état-major Russe sur la dernière campagne de Turquie*, par J. Tolstoy, ancien officier d'état-major Russe. Paris, Ledoyen, 1829. *Dix chapitres sur la Guerre d'Orient.* Paris, Delaunay et Dupont, 1829.

to prevent the men from deserting on the road to the depôts; since the circumstance of being selected as a soldier was considered as tantamount to perpetual banishment from family and friends. Hence, it was no uncommon spectacle to see numbers of these wretched serfs fastened together like a cordon of felons going to the hulks, or tied on telegas or carts, and thus conveyed to the depôt. But since leave has been given to soldiers to visit, at intervals, their native villages, and the period of service has been limited to 20 years, the dislike to the army has begun to abate, and recruits show less disposition to desert, although the military profession is still sufficiently unpopular. When the recruit, or rather conscript, arrives at the depôt, he is immediately stripped, washed, and shaved. If he wishes to retain any article of the dress which he brought with him, he is obliged to purchase it back. The only thing he is allowed to retain, without paying for it, is the cross of silver or brass which he wears round his neck. This superstition spares him as the only consolation of his miserable existence; and because, however passive in other respects, the most abject serf would become dangerous if deprived of an emblem which had probably been handed down from father to son for many generations, and the loss of which is considered the greatest misfortune.

The Russian soldier is docile, submissive, and brave. Like all slaves, he is supple, subservient, and cunning; like all natives of the northern regions, he is hardy, patient, and enduring. He has no other thought than to do implicitly as he is desired; and there is a pertinacity in his nature which inclines him to persevere, or to stand firm, as the case may be, without troubling himself about consequences. His courage is the result of insensibility rather than of moral force of character; and hence it is commonly more of a passive than of an active character. But there is, nevertheless, an element of indomitable ferocity in his composition: amidst all the apparatus and parade of civilization he is still three parts a barbarian. Hence his most brilliant achievements have been performed under men upon whom the force of civilization had made as little impression as on himself, and whom the instinct of sympathy had taught to develop his natural barbarism. The Italian campaign of Suwaroff affords a striking illustration of this remark. When that "hero-buffoon" arrived in Italy at the head of his 20,000 Russians to take the command-in-chief of the allied forces, General Chasteler, head of the staff of the army, proposed to him to make a *reconnaissance* of the French, who had retired behind the Oglio. "Des reconnaissances!" exclaimed the Muscovite chief, "je n'en veux pas; elles ne servent qu'aux gens timides, et pour avertir l'ennemi qu'on arrive; on trouve toujours l'ennemi quand on veut. Des colonnes, la baïonnette, l'arme blanche, attaquer, enfoncer,—voilà mes reconnaissances!" At Novi, at the Trebbia, and during his extraordinary campaign in the mountains of Switzerland, this wonderful barbarian, who had the instinct of genius, and a *coup d'œil* which has never been surpassed, proved that these were not empty words. By a kind of rude but infallible inspiration he discerned intuitively the true strategic points on which to move; and by the spell of his genius he rendered the Muscovite soldier invincible. In the campaign of 1812, we find another, though less striking, illustration of this peculiar characteristic of the Russian troops. Barclay de Tolly, a foreigner[1] in character and feeling, commanded in the early part of it; displaying a watchfulness, a prudence, and a sagacity in divining the intentions of his adversary, which proved him a great master in the art of war, and, beyond all question, saved the Russian empire. But still the army was discouraged; and Alexander felt it necessary to place at its head, as well as second in command, two of the ancient companions in arms of the conqueror of Italy. Its courage instantly revived; and the bloody day of Borodino, attested how well it repaid this compliance with its wishes. From that day onward—inspired by success—the Russian army has acquired a solidity of character which has rendered it formidable to its enemies wherever it has appeared in the field. Before its numbers, its perseverance, and the skill of its generals, the last remnant of Polish independance was extinguished in 1830–31. Turkey and Persia have felt its terrible influence since the Emperor Nicholas succeeded to the imperial throne; the Caucasian range has been penetrated, and the Usbecs have learned that wide wastes present no obstacle to the advance of the forces of a European monarch bent on conquest. But perhaps it was in the defence of Sevastopol that the severe discipline, the untiring energy, the profound science, the patriotic devotion, and the indomitable valour of a Russian army were most powerfully developed. The rapidity with which earthworks of the most formidable and complete character were raised for the defence of the beleaguered town, excited the astonishment, and for a long time baffled the efforts of the allies. The results of the terrible bombardment of a day were effaced in the course of a single night. Nor was it only in the engineering skill of the Russians that the stubbornness of their defence was manifested. Their sorties were numerous and distinguished by a rare audacity; and when at length the daring and constancy of the French and English triumphed over their honourable obstinacy, they crowned their steady resistance by a retreat calmly effected across the harbour on a bridge of boats and rafts constructed in the face of an enemy's fire.

The Russians have a strongly-marked national character, which foreigners can never duly appreciate; nor will its best energies be displayed in war, except under the command of men who feel its influence as powerfully as the meanest soldier in its ranks. The moral force of their army consists in a certain nondescript fanatical ferocity, which such men as Suwaroff, Bagration, and Kutusoff can alone fully develop.[2]

Be it said, however, in all justice, that the leaders who

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[1] He was of Scottish descent.

[2] Lieutenant-General Baron Jomini describes the Russian soldier with that predilection in his favour which may not unnaturally be expected from the *aide-de-camp general de S. M. L'Empereur de Russie;* and *grand croix de plusieurs ordres.* But even while he paints *en beau* that infantry "qui avait prouvé à Pultava, à Kunersdorf, à Choczim, à Ismaël, et dans mille actions contre les Turcs ou les Suedois, ce qu'on peut attendre de son inébranlable fermeté," he shows his usual discrimination of military character, and makes several observations which appear to us equally striking and original. "L'opinion géneralement accreditée en Europe," says he, "que le paysan Russe, ne possédant rien, gagne beaucoup à devenir soldat, est denuée de fondement. Un grand nombre d'entre eux, outre les champs de ses maîtres, cultive des fruits, des légumes, travaille et trafique à son compte. Beaucoup sont à leur aise; et la vie du soldat dans l'interieur du pays, ne leur porte pas envie au point de la désirer. Mais quand ce paysan est sous les drapeaux, il s'y attache comme à une seconde patrie......Elevé de la manière la plus rude, sous un climat terrible, il est le plus robuste de l'Europe, le plus capable de soutenir les fatigues et les privations. Il ne connaît rien de plus sacré que ses devoirs; soumis à l'ordonnance comme aux précepts de sa réligion, aucune fatigue, aucune intempérie, ne peut lui faire négliger les obligations qu'elle impose. On voit dans toutes les marches et durant une campagne entière, le cannonier près de sa pièce, au poste qui lui est assigné par le réglement, et à moins d'être frappé par le fer ennemi ou autorisé par son chef, il ne la quitterait pour rien au monde. Le soldat du train cire son harnais au bivouac par 15 degrés de froid et aux jours fixés, comme il le ferait dans un bon cantonnement pour aller à une parade. Cet esprit admirable d'ordre et de précision, joint à l'instinct naturel que le soldat a de se pelotonner au lieu de fuir quand il est enfoncé, rend les défaites extrémement rares. Sans doute, une telle troupe est moins facile à rallier sur le terrain qu'une armée Française, où l'intelligence du soldat supplée souvent au défaut d'ordre; mais elle est aussi plus difficile à rompre......Cet instinct qu'aucune des troupes de l'Europe

are the most conspicuous in the defence of Sevastopol, and the prosecution of the last campaign in Asia, distinguished themselves as much by their harmony and courtesy as by their courage and intelligence. The most enlightened British and French generals found honourable emulators in Prince Menschikoff, Prince Gortschakoff, and General Mouravieff.

Swedish army.

In Sweden, union and confidence have always subsisted between the soldier and the citizen; and hence the desire of military service is so common among all classes of the nation, that sending a man to the army is not there, as elsewhere, a punishment. In 1811, when the peasantry broke out in insurrection against the conscription by ballot, they offered to take arms without exception in the event of war, to submit to be drilled together in time of peace, and to equip themselves at their own charge, provided the obnoxious innovation was abolished; tenders which were wisely accepted on the part of the government. The present military establishment of Sweden is considerably below what a nation constitutionally warlike might be supposed to maintain; but as the aim of the government is to husband the public money, and, if possible, to relieve the country from the pecuniary difficulties entailed upon it by the folly and extravagance of the ex-king, all the departments of the public service have been placed on the most economical footing. The actual standing army, accordingly, does not exceed 35,000 men of all arms. The militia, however, is more numerous; and, from the peculiar aptitude of the Swedes for military exercises, it exhibits a very soldier-like appearance, though only trained for a few weeks annually. Like the regular army, it is composed both of horse and foot, and must afford a ready resource in the event of war. The organization of the whole is excellent. The regiments of the line are recruited neither by voluntary enrolment nor by conscription, but by a kind of intermediate system; every landed proprietor furnishing a certain number of soldiers, to each of whom a house and a portion of land are allotted for his maintenance. The Swedes have been long and justly celebrated for their martial qualities; and no modern nation of so small extent has made so conspicuous a figure in history. They are brave, hardy, and naturally heroic men; of superior physical and corresponding moral power; and, as soldiers, equal to any in the world.[1]

Danish army.

The Danish army consists of rather more than 30,000 men, with a reserve of about 14,000. Of this force 2157 are divided throughout the kingdom of Denmark, and 9655 stationed in the duchies; while the remainder are employed in garrison, or occupy cantonments in the vicinity of the capital. The whole is composed of a staff of 23 officers; a corps of engineers of 32; an artillery corps of 3202 men, divided into 22 companies; 6126 cavalry, divided into ten regiments, one of which is a regiment of guards; 13,412 infantry, divided into thirteen regiments of two battalions each, one of which is also a regiment of guards; 2753 chasseurs, divided into five battalions of four companies each; and, lastly, a rocket corps, amounting to 156 men. The two regiments of guards are composed of very fine men, and have a noble appearance. The artillery consists of twenty batteries of eight pieces each; besides a company of sappers and miners, one of pontoon men and pioneers, with a detachment of artificers, and a laboratory establishment.

The Danish soldier is a quiet, hard-working man, who goes about the peasant's farmyard like one of his own farm-servants, puts up with the same fare and lodging, looks after the cattle, feeds the pigs, and makes himself useful. The Danish service was notorious formerly for the barbarity of its discipline. The slightest error in observing the most absurd regulations in dress and drill incurred the most severe corporal punishment. The cane of the under-officer was incessantly at work on the shoulders of the wretched soldier. It was not uncommon sixty years ago for the men to sit up all night previous to a grand review, to tie their queues, powder their hair, and save it from being deranged by lying down; as the slightest derangement or want of uniformity in pigtails or sidelocks brought down severe punishment. Suicide was frequent; and officers as well as men were brutalized by the cruelties they had to witness, inflict, and suffer. The late king, Christian VIII., abolished entirely, and at once, the infliction of corporal punishment at the discretion of officers and under-officers. The minor military transgressions could only be punished by arrest, extra duty, and such punishments as are now adopted in our army; flogging and caning were abolished. The officers of the old school of military discipline and dress, the martinets of the parade-ground, predicted the entire ruin of their well-drilled, well-cudgelled little army, by these innovations. The men were no longer enlisted for life. They served only three years, after which, those who wished to become under-officers, served two years in a military school, and three years afterwards as under-officers; and eight years concluded their term of military service, unless they chose to re-engage. The clothing, dress, drill, were simplified; and the Danish soldier is now scarcely distinguishable from the Prussian or other German soldiers. The Danish army is composed of peasants accustomed to hard work, from the great exertions which their climate imposes on the husbandman to get his seed into the ground in due season. Wet and cold and night work, hardship, and labour, are familiar to them; and the Jutlanders, in particular, are men of greater physical powers, and more roughly bred and fed, and hardier than the peasantry of Holstein, or of the south of Schleswig. The Danish soldiery, and the classes from which they are drawn, are, at this day, men of the same character as the peasantry of the feudal ages. They have the same implicit confidence in, and personal attachment to, their leaders. Their captains, lieutenants, and under-officers are to them what the baron, his standard-bearers, squires, and pages were to their forefathers. Their relation is preserved in the army from the men and officers growing up together in the same regiment, and becoming known to each other. Officers are rarely shifted from the regiment in which they have begun their service, and regiments are rarely removed, in time of peace, from the province in which they have been first raised or quartered. The Danish soldier, like the peasant in the days of chivalry, thinks the real battle is but beginning when, in most modern armies, it is considered ending—when the combatants come hand to hand in the charge of bayonets. The firing is considered a mere preliminary, however bloody; and at Idstadt, and again at the siege of Frederickstadt, during the war with Prussia, regarding the duchy of Schleswig-Holstein in 1849-50, the Danish troops slackened, and even ceased their fire altogether, on command—a manœuvre, in face of the enemy, and in the heat of an engagement, which few troops of the most highly disciplined armies would have the coolness to practise, or their commanders the confidence in their men to venture upon. But the implicit confidence of the Danish soldiery in their leaders, and of the leaders in their men, and their military intelligence and submission to

ne possède au même degré, s'est fortifié chez les Russes par les guerres contre les Turcs. Là, tout fuyard est sabré par les nuées de cavaliers qui se répandent sur les flancs et les derrières de l'armée. Ce n'est qu'en restant fermes et réunies qu'on échappe à une destruction inévitable." This is a tolerably good reason for the "instinct" of which the gallant author speaks. He adds, "La plus parfaite egalité règne dans l'armée, car une fois dans la carrière des armes, aucun obstacle n'empêche de la parcourir. Pour s'en convaincre, on n'a qu'à voir les noms des généraux distingués dans l'histoire militaire de Russie; on y trouvera autant de plébéiens, ou de bas-officiers parvenus par leur mérite, que dans tout autre pays." (*Guerres de la Révolution*, tom. i., p. 254–256.)

[1] Alexander's *Travels*, vol. ii., p. 267.

Army.

orders, seem innate. Their ideas of warfare are formed on the tales and ballads of the times of chivalry, when personal combats decided battles; and no country is so rich in popular songs and traditionary stories, from the fourteenth and fifteenth centuries.

Waldemar Scier (the Victorious), his good queen Dagmal, the wars in the unhappy times of his sons, and of Eric of Pomerania and his gallant queen Philippa, the sister of our Henry V., and the exploits of the knight Ebbesen, and his battles against the Holstein Count Gert, are household literature among the Danish peasantry, and, as far as literature can do so, have formed the character of the people. The Danish soldiers are men of the fifteenth century, led by officers of the nineteenth. The under-officers appear to stand on a higher footing in the Danish service than the non-commissioned in ours. They are appointed in the same way, by the recommendation of the captain of the company, and are selected from the soldiers of three years' service. On their appointment they are sent for two years to the military academy, where they are instructed in various branches of knowledge connected with military duty, which they could not be taught so well with their regiments. Outpost-duty, patrol-duty, and all that depends upon the military intelligence and eye of the under-officer, was done in a more satisfactory manner in the Danish than in the insurgent army. The latter was under great disadvantage in the field from want of experienced or instructed under-officers, and officers who understood and had the confidence of the men. The defeat of the "Schleswig-Holstein" army is attributed to this want by the German officers who have written on the war. The Danish non-commissioned officers have the moral weight of a better educated class, as well as that of their military rank, among the men. The officers are highly-educated, gentlemanly men, superior in tastes and acquirements to the majority of our officers, their education being very much superior. They are all bred from a very early age at the military academy of Copenhagen, in which the languages and literature of other countries, as well as of their own, and all the mathematical and other sciences connected with the military profession, are very carefully taught, and they undergo very strict examinations before they pass as cadets. They join a regiment as privates in the ranks, rise to be under-officers, in which rank they remain for two or three years, and are appointed second-lieutenants afterwards, and rise by seniority in regimental rank. Captains and subalterns, both in cavalry and infantry regiments, are, in general, as young men for their rank as officers in our service. The military officers are often provided for, after long and meritorious service, by offices in the customs or the forest department. The subaltern officer is not allowed to marry unless he can prove that, besides his pay, he and his proposed wife have an income of 600 dollars; and he must also insure his life to the extent that his widow may enjoy an annuity equivalent to his pay. The pay is small; about 400 dollars yearly, or about L.45 sterling, is the pay of a lieutenant: but, on actual service, the officer has a field allowance, and living is extremely moderate. It is not merely the cheapness of provisions, but the simpler habits of living that make one country less expensive than another. The officer in Denmark maintains his station in society on his small pay, and is, in manners, appearance, education, and all gentlemanly accomplishments and feelings, equal to the best of our own regimental officers, and very superior to the many ignorant, uninformed youths who formerly joined our regiments without any preparatory education or examination. The artillery of the Danish army is said to be excellent; and ball practice with artillery is even a favourite amusement, on summer evenings, with the citizens of Copenhagen. In the Danish dominions the inhabitants of the great towns are exempt from the conscription for the landwehr, or general military service, but they furnish battalions of local militia, which do military duty in the town as part of the garrison, and which elect their own officers, up to captains inclusive, and are clothed and equipped at the expense of the corporations. They are a kind of volunteer force, but liable to serve, in the event of an invasion, like other troops, and then receive pay, subsistence, and quarters, according to their rank, like the officers and men of the regular army. The artillery of the city of Copenhagen was called out in the last war; and the "shoemaker's brigade," as it was called by the soldiers, from its captain being a respectable tradesman of that craft, an amateur artillerist, was as well served, and as effective in the field, during the three years of warfare, as any brigade of guns in the army.[1]

Saxon army.

The electorate of Saxony, with a superficies of 717 square miles, a population of 2,104,336 souls, and a revenue of about 780,000 thalers, maintained in 1792 an army of about 32,000 men, being a 66th part of the population; and on this footing it remained till 1800, when it was increased to 38,000 men, being a 56th part of the population. But Saxony having in 1802 gained a small increase of territory in consequence of the treaty of Luneville, though, at the same time, it lost about 1,778,000 thalers of revenue, the army was reduced to 31,000 men, of which 22,000 were infantry and 6700 cavalry. This state of things continued until 1806, when the military force was raised to 36,000—Saxony having then a population of 2,276,000 souls. In the year 1809 she furnished a contingent to France of 16,000 men, who, under the command of Bernadotte, afterwards king of Sweden, took part in the memorable campaign of that year, and fought at the battle of Wagram; but the Emperor Napoleon was so little satisfied, either with the conduct of these troops, or that of their leader, on this occasion, that he was with difficulty prevented from stigmatizing both in the orders of the day. After the peace of Vienna in 1810, the Saxon army was reorganized upon the model of the French, and its contingent of 16,000 men formed the seventh corps of the grand army which invaded Russia in 1812. It was commanded by General Reynier. On the disastrous termination of the Russian campaign, its wrecks, reorganized from the troops remaining in Saxony, entered into line in 1813, after the battle of Lutzen; and on the conclusion of the armistice with the Hessian corps and that of General Durutte, it formed again the seventh division. The defection of the Saxon divisions at Leipzig, on the 18th of October 1813, is well known. The king of Saxony having lost his liberty in consequence of the result of that disastrous day, his army was dissolved and replaced by a landwehr of from 10,000 to 12,000 men, which followed in the train of the allied armies when they invaded France. In 1815, however, the army was reconstituted to the extent of a third of its former strength; and underwent various changes until 1824, when it was placed upon a still better footing. During the past two years it has been further strengthened to meet possible exigencies. The *infantry* at present (1856) consists of four brigades of infantry of four battalions each, making 15,748 men and officers; a brigade of chasseurs of four battalions of four companies each, or 4005 men. The *cavalry*, which formerly consisted of horse guards, cuirassiers, hulans, and hussars, has been transformed into four regiments of light horse, consisting of four squadrons—in all 3208. The *artillery* consists of one regiment making twelve companies, two of which are horse, amounting to 2420 sub-officers and soldiers, together with a train of 189 men and as many horses. A dozen officers without troops, and a company of sappers 67 strong, compose the *engineer* department. The institutions connected with the army are a school for cadets, and a military academy, both at Dresden. The reputation of

[1] *Denmark and the Duchies*, by Samuel Laing.

the Saxon infantry is low; but the cavalry is better than the infantry, and is well qualified for the service of the advanced posts, which was its usual destination under Napoleon.[1]

Hanoverian army.

The composition of the Hanoverian army is as follows:—The *infantry* consists of eight regiments of two battalions each, and two light infantry regiments. There are two of these regiments guards; and the whole are divided into three brigades, the first consisting of five regiments, the second of four, and the third of three. There are six regiments of *cavalry*, two of cuirassiers of the guard, two of hussars, and two of dragoons; and each regiment is composed of four squadrons, 48 officers, 433 men, and 403 horses. The *artillery* consists of one brigade divided into ten companies, one of which is horse, and contains 70 officers, 1449 men, and 210 horses. The corps of *engineers* and artificers consist of 198 officers and men. The artillery is of the English model and calibre, and its batteries, both horse and foot, consist of six pieces and a howitzer each. The total strength of the army, including the staff, amounts to 24,197 men and officers. The period of service in the infantry of the guard is four years only, but in all the other corps six years. The cavalry and artillery are recruited as much as possible from volunteers. The Hanoverians make excellent soldiers; and it is well known that, during the Peninsular campaigns, no part of the Duke of Wellington's army more frequently distinguished itself than the King's German Legion, which was almost exclusively composed of Hanoverian volunteers.[2]

Bavarian army.

The Bavarian is one of the largest of the third-rate armies. Its *infantry* consists of a regiment of grenadiers of the guard in three battalions, of 16 regiments of the line in two, and of six battalions of chasseurs—presenting an effective force of 41 battalions, or 58,560 men. Its *cavalry* is composed of eight regiments, in seven squadrons each, forming a total of 56 squadrons, or 11,584 men, and horses in proportion. The *artillery corps*, commanded by a lieutenant-general, consists of two regiments of cannoneers of 15 batteries, one regiment of horse artillery, and two divisions of artificers, pontoniers, sappers, and miners—making a total of upwards of 11,000 men. The *engineer corps* is composed of a general, a colonel, a lieutenant-colonel, two majors, two captains, eight lieutenants of the first class, eight of the second, and six conductors, and is divided among the five directions of Munich, Augsburg, Nuremberg, Wurtzburg, and Lindau. The Bavarian army, therefore, consists in all of 91,452 men. Every Bavarian, the clergy only excepted, is obliged to bear arms in defence of his country; but, in practice, students and persons necessary to their families are usually exempted; and permission is likewise granted to serve by substitute. The method of recruitment is conscription. Besides the permanent army, there is a reserve destined to reinforce it; and, in the event of war, the landwehr may be equally called upon to support the army, when reinforced by the battalions of the reserve, but only in the interior. The *landwehr* is divided into two classes, one of which comprehends those who are least capable of performing active service, and who cannot in any case be employed beyond the limits of their district. In time of peace it co-operates in the maintenance of public tranquillity, when put in requisition for that purpose, and when the troops of the line are deemed insufficient. The reserve and the landwehr amount to 70,000. The Bavarian army is well organized, and has always maintained a respectable character for discipline and bravery. The cavalry is considered superior to the infantry.[3]

Armies of Wurtemberg and Baden.

The small army of Wurtemberg requires only a brief notice. Its *infantry* consists of 8 regiments of 2 battalions, divided each into four companies; its *cavalry*, of a squadron of guards, a squadron of chasseurs, and 4 regiments of horse, each divided into 4 squadrons; its *artillery*, of a regiment of 6 companies, 3 horse and 3 foot, besides a garrison company; but it has no engineer corps distinct from that of the artillery. Its peace establishment is composed of 9189 combatants, and 1806 horse: on a war footing it would amount to 22,000 combatants. The Wurtemberg army is recruited by voluntary enrolment and forced levies. The military age is from 18 to 30 for enrolment, and from 20 to 25 for levies; and, in both cases, the élite of the population only is taken. This little army is well officered, and enjoys some consideration. The grand duchy of Baden, the seventh state of the Germanic confederation, has a superficies of 279 square miles, with a population of 1,356,943 souls, and supports a military establishment of 15,000 men, although it is only bound to furnish a division of 10,000 men (the 2d of the third corps) as its contingent.[4]

Army of the Germanic confederation.

The organic law of the military constitution of the Germanic confederation, adopted on the 9th April 1821, in the fifteenth full sitting of the diet, and forming the basis on which the federal army has been organized, is exceedingly complex, and altogether unsusceptible of analysis within the space which the limits of this article afford. Its leading provisions, however, may be shortly stated, and are as follow:—The army of the confederation is composed of the contingents of all the states members thereof, raised according to the formation of their particular *matricule* or computation in the diet. The proportion of the different arms is regulated conformably to the principles of the new tactics. The federal army is formed of corps d'armée of a single nation or of combined corps, and both are subdivided into divisions, brigades, and regiments. No state of the confederation, whose contingent forms one or more corps d'armée, can combine contingents of other states with its own in the same division; and the states which have corps or divisions combined, concert together the manner of forming and organizing them; and in case of dispute, the diet decides. In the organization of the federal army regard is had to the interest resulting from the particular relations of different states, in as far as can be done consistently with the general object of the confederation; and as the rights and duties of all the confederate states are the same, it is specially provided that every appearance of supremacy on the part of one state over another is to be avoided. The contingent of each state must always be completely equipped and ready to take the field as soon as it shall be called to do so; but the force and assembling of the army to be raised, as well as of the reserve, are regulated by particular dispositions of the diet. 1. The ordinary contingent of each state is one-hundredth part of its population, conformably to a table prepared and rectified from time to time by the diet. 2. The proportion of the cavalry of the federal army is fixed at one-seventh of the total of the troops; and two field-pieces are required for every 2000 men of the contingent, besides one for every 1000 of the reserve in arsenal. 3. The federal army consists of 10 corps d'armée, 7 simple and 3 combined, designed in the order of the digits or primary numbers; and every corps has at least 2 divisions, each division at least 2 brigades, each brigade at least two regiments, each regiment of infantry at least two battalions of 800 men each, and each regiment of cavalry at least 4 squadrons of 140 men each. The *minimum* of a contingent of cavalry is 300 horse; of

[1] *Coup d'Œil sur la Force et l'Organisation de l'Armée Saxonne depuis* 1792 *jusqu'en* 1824. Paris, 1825. *Geist der Zeit.* Feb. 1824. *Bulletin des Scien. Milit.* ii. 49.

[2] *Militär Blätter*, vol. i., p. 183. 1821. *Bulletin des Scien. Milit.* ii. 55. 1825. *Almanach de Gotha.* 1856.

[3] *Zeitschrift für Kriegswissenschaft*, No. 24, p. 242. *Hof und Staats Handbuch des Königreichs Bayern.* Munich, 1828. *Almanach de Gotha*, 1856.

[4] *Allgemeine Militär Zeitung*, No. 10, 1828. *Bulletin des Scien. Milit.*, tom. vi., p. 65.

Army. infantry, 400 men; and of artillery, a battery of six or eight pieces. 4. As the contingent of each state must be ready to take the field in a month after it is called upon, all the *matériel* of armament and provisions necessary for the contingent must be deposited in the arsenals of each state, and all the contingents of the army must be kept up to their full complement even in time of peace. 5. The generalissimo of the confederation is chosen by the diet in ordinary assembly, and his functions cease when the federal army is dissolved. 6. The commanders of the corps of every nation or state have the rights which the sovereign whose troops they command may think proper to confer upon them, without deviating from the principles upon which the military constitution is founded. There is a great number of other dispositions and regulations, touching a variety of matters; but those above specified are the principal, and may serve to convey an idea of the military constitution of this great confederacy, organized in imitation of that which, while it seemed to strengthen the hands of Napoleon, proved eventually, by the defection of its members, one of the chief causes of accelerating his fall.[1]

Netherlands armies. The military power of the United Provinces dates its commencement from the middle of the fifteenth century, when, after a long and sanguinary struggle, they succeeded in emancipating themselves from the yoke of Spain; and in the following century it received considerable development in consequence of the wars which they had to maintain against Louis XIV. In 1702 they had in their pay upwards of 100,000 men, exclusive of 30,000 who were in the service of the Dutch East India Company. But this period may be regarded as the highest condition of the army of Holland, which subsequently declined both in number and reputation; so that in 1775 it did not exceed 30,000 men, fully one-third of whom were foreigners. In 1789, Holland, with a population of 2,340,000 souls, inhabiting a country of 625 square miles, supported an army of 36,000 men, consisting of 40 regiments of infantry and 10 of cavalry; and with this force it joined the first coalition against the French republic. In 1792 the Dutch army had been increased to 39,000 infantry, 3450 cavalry, 1560 artillery, and 260 miners and pontoniers; making a total of 44,270 combatants. But in the campaigns of 1793 and 1794 they afforded the Prince of Orange occasion for displaying considerable military talents, put his army to a decisive test, and impressed all with a conviction that its degeneracy in moral force was equalled only by the radical defects of its organization. The conquest of Holland by the French, however, was followed, in 1795, by the re-organization of the army on new bases; and so great was the effect of the changes thus introduced, that the Batavian troops, led by Dumonceau and Daendels, rivalled the French, by whose side they fought, both in discipline and valour; and at Alkmaër, on the Rednitz, and on the Danube, bravely upheld the ancient reputation of the Dutch arms. At the peace of 1815, Belgium having been united to Holland in order to form a constitutional monarchy, and England having restored the greater part of the Dutch colonies which had fallen into its hands during the republican and imperial regime, the new kingdom of the Netherlands at once, and as it were *per saltum*, took its place among states of the second order, with a continental superficies of 1165 square miles, and a population of 6,166,854; and lost no time in organizing a military system suited to its position and rank among the nations of Europe.

Belgian Army.—But, in 1830, a revolution having broken out in France, its influence extended to Brussels. The Belgian provinces were severed from the crown of Holland in August of that year. In July of the following year (Belgium having in the meanwhile assumed a republican form) the allied powers of Europe recognised the independence of the state, and it was declared a kingdom—Prince Leopold of Saxe Coburg being elected to the sovereignty. A soldier himself, and aware how much the Belgian frontier was exposed to aggression, he paid great attention to the constitution of the army; and at this moment it rivals, in discipline, order, and intelligence, the best armies in Europe. The force was fixed in 1836 at 42,000 men, but its numbers vary with the appearance of danger; and at this time (January 1856) it is composed of 73,718 men and 10,600 horses. The force is divided into infantry of the line, carabineers, grenadiers, horse and foot chasseurs, lancers, cuirassiers, guides, gens-d'armes, and a considerable train of artillery, sappers, miners, &c. There is likewise an extensive general staff, a staff corps, a provincial staff, an administrative service, and a health establishment. The general staff comprises 9 lieutenant-generals and 18 major-generals in active service; 2 lieutenant-generals and 4 major-generals in reserve. The staff corps consists of 12 superior and 40 subaltern officers. The provincial staff comprises 5 commandants of provinces (generals or colonels), 21 commandants of fortresses, and 35 fort-adjutants. In the administrative service are—1 superintendent-in-chief, 1 first-class and 4 second-class superintendents, and 16 sous-intendants or inferior superintendents; 29 captains quartermasters, 61 paymasters, and 29 barrackmasters. The health service or medical department is composed of 1 inspector-general, 4 surgeons-in-chief, 7 garrison surgeons, 28 regimental surgeons, 29 surgeons of battalions of the first-class, and 38 ditto of the second, 20 assistants, 1 principal physician, 30 physicians of three classes, 1 veterinary inspector, and 27 veterinary surgeons of the first, second, and third class.

The infantry consists of 1 regiment of carabineers, 2 of chasseurs, 1 of grenadiers, and 12 of the line. These regiments are divided into three active and two reserve battalions each, the carabineers having four battalions of the one and two of the other. There are likewise two stationary companies (*compagnies sedentaires*), one disciplinary division, and one company of enfants de troupe. The staff of each regiment is composed of 1 colonel, 1 lieutenant-colonel, 1 adjutant-major, and 2 paymasters. Each service battalion has 1 major and 1 adjutant; each reserve battalion 1 major and 1 paymaster; each active company contains 1 captain, 1 lieutenant, and 1 sub-lieutenant; each reserve company 1 captain and 1 lieutenant; and each depôt company 1 major, 1 captain, 1 lieutenant, and 1 sub-lieutenant.

The *Cavalry* is composed of light and heavy. The former are divided into 2 regiments of dragoons and 2 of lancers, each of 6 active and 1 reserve squadron; and the latter consist of 2 regiments of cuirassiers of 4 active and 1 reserve squadron; and a regiment of guides of 6 active and 1 reserve squadron. The staff of each regiment consists of 1 colonel, 1 lieutenant-colonel, 2 or 3 majors (according to the number of squadrons), 1 captain and adjutant, 1 lieutenant-adjutant, and a paymaster. The squadrons comprehend each, 1 captain, 1 captain *en second*, 2 lieutenants, and 2 sub-lieutenants; and the depôt squadron line, 1 captain instructor, 1 captain commandant, 1 lieutenant, and one sub-lieutenant.

The *Artillery* consists of a staff of 14 superior and 19 subaltern officers, 9 commandants of artillery, and 24 *gardes d'artillerie*. There is one regiment of horse-artillery, divided into 4 field and 6 siege batteries; and 3 regiments of foot artillery, each containing 5 field and 6 siege batteries; a company of pontoniers, a company of artillery artificers, one of armoury artificers, and a field train. The staff of a regiment consists of 1 colonel, 1 lieutenant-colonel, 3 majors, 1 captain and adjutant, 1 lieutenant and adjutant, 1 captain instructor, and 1 paymaster. Each horse battery comprehends 1 captain commandant, 1 captain *en second*,

[1] *Bulletin des Sciences Milit.* tom. ii., p. 45. *Loi Organique de la Constitution Militaire de la Confédération Germanique*, 1821.

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2 lieutenants and 2 sub-lieutenants; each battery of foot artillery has a captain commandant, a captain *en second*, and 3 lieutenants or sub-lieutenants. A siege and depôt battery consist of 1 captain commandant, 1 lieutenant, and 1 sub-lieutenant. In the pontoon company are—1 captain commandant, 1 captain *en second*, 2 lieutenants, and 2 sub-lieutenants. Each company of artificers contains 1 captain commandant, 1 lieutenant, and 2 sub-lieutenants. The field train contains 1 captain, 1 captain *en second*, and 3 lieutenants or sub-lieutenants.

The *Engineers* are composed of a staff of 13 superior and 47 subaltern officers, and a regiment of 2 battalions; each battalion consisting of five companies. The staff of the regiment consists of 1 colonel, 1 lieutenant-colonel, 1 captain and adjutant, 1 paymaster; each battalion has one major and an adjutant; and each company is composed of 1 first and 1 second captain, 1 lieutenant and 1 second lieutenant. The administration comprises 12 directors of hospitals, 12 sub-directors, 256 hospital employés, 16 directors of the bakery, and 136 employés therein.[1]

But besides the regular army, the whole country is formed into a civic or national guard of 600,000 men. It is divided into three corps or *bans*, each of which is subdivided into legions, and the whole guard is raised in the different provinces in just proportions. There is no time lost in the Belgian army; a course of military instruction, of every description, of the most practical utility, being unceasingly pursued the whole year round. In winter, when the troops leave the camp, their marching *out* commences, and these marches are about 10 miles out and 10 miles in. They never neglect a single opportunity of brigading these regiments in the different garrisons; it being a standing order that brigade field-days should take place regularly twice a-week, even where only two regiments are quartered together. Major Harvey, on the staff of the late Lord Frederick Fitzclarence, who had an opportunity of seeing the Belgian army in one of its camps of instruction, says, "I personally accompanied the general in going round the line of sentries; and was permitted to put many questions as to his method of completely protecting his front and flanks. The regiment of lancers, under the command of Colonel Bester, attached to this brigade, admirably performed their part, scouring the roads in every direction, and sending in continual reports from their different patrolling parties, their videttes being posted with consummate judgment and intelligence. Nor can I pass over my astonishment at the energy and rapidity with which the column of infantry, composed of such young soldiers, pushed forward through a deep sandy 'defile' of two miles in length; nor how thoroughly they seemed to understand and execute the principles of squeezing as large a front as possible over and through the different obstacles they met with, preserving their original extent of front up to the very last moment, by which means the tail of the column was always in its right place, and not a straggler lagged behind. In short, I never remember to have seen the spirit of General Craufurd's light division orders for the line of march more rigidly adhered to, or more admirably carried out. But whether in the mere pipeclay and parade movements in the open plain, where accuracy and uniformity of execution formed the principal features, and where General L'Oliver's remarkable skill in handling his troops was so conspicuous, or in the more essential movements of a campaign, such as passages of *défilés*, combined movements by various columns directed on certain points, out-post duties, &c., there was an amount of intelligence and practical confidence throughout, which impressed me with the conviction that a small '*corps d'armée*' so well in hand, and so ably commanded, would feel themselves quite a match for a far more numerous, but less practised force."[2]

Army.

The Dutch Army.—The army of Holland is of nearly equal strength with that of Belgium, and has had the advantage of much careful drilling by Prussian officers. The militia, however, does not approach the numerical strength of that of Belgium. Holland rests her defensive strength upon her navy, and trusts to the influence of alliances for her internal tranquillity. The composition of the Dutch army corresponds with that of Belgium. The general staff consists of 10 lieutenant-generals and 16 major-generals, and the staff-corps of 7 superior and 19 subaltern officers. The staff of the provinces and strong places is composed of 10 commandants of provinces, 8 commandants of fortresses, and 29 fort-adjutants. The corps of "intendance" consists of 1 intendant-general, with the rank of general; 1 of the first and 1 of the second class; 2 sub-intendants of the first class, and 3 of the second class; 2 adjutants, 21 captains-quartermasters, 51 paymasters, 21 administrators of quarters. The health department consists of 1 inspector-general, with the rank of general, 1 inspector, 6 first-class health officers, 120 health officers, 27 physicians, and 3 veterinary surgeons. The total of the force is 1701 officers and 56,946 soldiers.

The *Infantry* is composed of one regiment of grenadiers and chasseurs (light infantry), divided into four battalions of 5 companies each; 8 reimgents of the line, each containing 4 battalions of 5 companies, and 2 depôt companies; 1 battalion of instruction, a depôt of discipline, and a recruiting depôt. The infantry officers are 866 in number, thus divided—2 superior and 25 subaltern, forming the staff; 5 superior and 74 inferior in the grenadier regiment; 48 superior and 672 subaltern in the 8 regiments of the line; 1 superior and 14 subaltern in the battalion of instruction; 1 superior and ten subaltern at the depôt of discipline; 1 superior and 13 subaltern in the recruiting department.

The *Cavalry* consists of a staff, 4 regiments of dragoons of 4 squadrons each, and 2 squadrons of the Limberg chasseurs, with 155 officers.

The *Artillery* comprehends 3 regiments of foot, and 1 of horse, a company of pontoniers, and 1 company of artificers. Each regiment consists of a staff, 5 horse batteries, 8 field batteries, 33 siege batteries, and 2 squadrons of a field train. The general staff comprehends 5 superior officers, 18 subalterns, and 32 *gardes d'artillerie*. The regimental staff of each regiment comprises 17 superior and 18 subaltern officers. Each siege battery has 1 captain and 3 lieutenants; and each field and horse battery 1 captain and 4 lieutenants and sub-lieutenants. The company of pontoniers is composed of 1 major, 2 captains, and 4 lieutenants and sub-lieutenants; the company of artificers of 1 captain and 6 lieutenants and sub-lieutenants; and the field train of 1 captain and 2 lieutenants.

The *Engineers* comprehend a battalion of 3 companies with 13 officers; and the staff consists of 88 officers.

Sardinian army.

SARDINIA is the Prussia of Italy. It has been from old times a military state in virtue of its geographical position between the two great military powers, France and Austria. Every Piedmontese (and this designation usually applies to the soldier of the Sardinian states) is liable to military service; and the man who has served his three years in the line remains disposable in case of war, for sixteen years to come.

Accustomed for ages past to these obligations, the Piedmontese has more military spirit than the Italian of any other district, and makes a good soldier. A nobility, numerous and brave, furnishes a body of officers worthy of command in such an army.

[1] *Journal de l'Armée Belge. Recueil d'Art, d'Histoire, et de Sciences Militaires.*

[2] *The Camp at Beverloo.* By Major H. B. Harvey, H.P., late Military Secretary to Lieut.-Gen. Lord Frederick Fitzclarence, G.C.H., Commander-in-Chief at Bombay.

Army.

The science of war is much cultivated at Turin; the artillery, both as regards theory and practice, is of the first class. It consists of 4763 privates, 331 officers, and 5 generals. The composition of the army is as follows:—30 generals, 3181 superior and inferior officers, and 44,413 rank and file. There are several brigades of infantry, each brigade consisting of 2 regiments, each regiment of 3 battalions, namely, 2 infantry of the line (5 companies each), and 10 jäger battalions of 4 companies. The brigades are designated Savoy, Piedmont, Aosta, Coni, Queen's, Cosale, Pignerol, Savora, and Acqui.

The infantry battalion, on its war footing, is from 1000 to 1100 strong, which gives to the whole infantry from 30 to 31,000 men. By calling in the reserves, this force may receive an accession of 10,000 men.

Of this infantry force, 3637 (about 10 battalions) are sharp-shooters—Bersaglieri (from *bersaglio*, an object aimed at). This body vies with the French voltigeur in activity, and with the heavy-armed Swiss rifleman in precision of aim, and is the admiration of all experienced judges. Marine infantry can also be applied on occasions of land service.

The cavalry consists of 4 heavy and 5 light regiments, numbering 315 officers, and 4896 privates. The regiments are named after certain towns and provinces—Royal Piedmont, Genoa, Nice, Savoy, Novara, and Aosta. Each regiment has about 600 horses. Its proper number for service, indeed, is 1000, but there is a difficulty in raising this amount, for the troop horses are generally imported from North Germany. Men and horses are fine in appearance. The lance was formerly confined to each fifth squadron, but of late all have been armed with it.

Besides these troops, there are royal carabineers, body guards, guards of the royal palaces, veterans, invalides, &c.

The engineer service is provided for by corps of sappers and miners.[1]

In the war with Austria in 1848, when the independence of Piedmont was threatened, the military prowess of Sardinia was powerfully displayed; but it was not until 1855, when 15,000 Sardinian troops joined England and France in the defence of Turkey against Russian encroachment, that an opportunity was offered of ascertaining, by comparison, the exact degree of their efficiency. It is hardly enough to say that they suffered nothing by the contrast. In many respects, their organization and equipment, their aptitude to meet the sudden emergencies of field service, and their admirable practice with rifle and ordnance, supplied examples of which the proudest military nations might avail themselves.

Neapolitan army.

The Neapolitan army is scarcely deserving of notice, either in a political or military point of view; for, next to the soldiers of his Holiness the Pope, those of Naples are beyond all dispute the worst in Europe. In 1792 the Neapolitan army amounted to 30,000 troops of the line, as they were called, and 15,000 militia—a force which was increased, in 1799, to 60,000 men of all arms; 40,000 of whom invaded the Roman states during the campaign of that year, and conducted themselves rather like banditti than a regular army. Formidable only to its allies, and to the country which it serves to retain in abject servitude, this army has since experienced the most violent mutations; but its number at present may be estimated at from 35,000 to 40,000 men of all arms.

Swiss troops.

The 24 cantons of Switzerland are defended in case of need by the militia, which, in fact, comprehends the whole of the adults who may either be actually in the country or elsewhere engaged. There are few Swiss who are not good soldiers, though no regular army is kept up; and so strong is their patriotism, that, when the fiery arrow goes forth, wherever they may be, they rally in defence of their native mountains.

The Swiss have for ages been the hirelings of Europe, either in public or private service, as soldiers, or as domestic servants. Pay has for ages been the only influence in general and constant operation on the Swiss mind, in every class of society, and has weakened the efficiency of any higher influence and feelings in affairs than self-interest—*Point d'argent, point de Suisse*, has extended from their military to all their social relations. A great proportion of the young men of Switzerland have small farms or houses, with portions of land, and rights to grazings in the Alp of their native parishes, to succeed to upon the death of their parents; but until that event in their social position, they are supernumeraries at home, their labour not being necessary for cultivating the paternal acres, and their subsistence costing more, perhaps, than the land can afford. They have no colonies to migrate to, no labour to turn to, except labour of skill, which all cannot learn or live by, and no considerable manufacturing employment, except in two or three cantons, to absorb their numbers; and they enlist, therefore, readily for a few years in Swiss regiments in foreign service. France, after the restoration of the Bourbons, had about 17,000 men of Swiss regiments; and the disgust of the French nation at the preference shown to these mercenaries was a main cause of the expulsion of Charles X. Naples has at present 4 regiments of these mercenaries; Rome as many; and England has a Swiss legion. It is reckoned that from 8000 to 10,000 Swiss are in foreign service at present, embodied generally in Swiss regiments distinct from the native troops of the country. They are the *condottieri* of the middle ages, serving for their pay, and without any other principle or attachment, real or assumed, or any pretext of higher motive for their service. In other services the rudest soldier, the most arrant scamp, the vagabond, the deserter from other regiments, lays the flattering unction to his soul, that destiny, folly, hard necessity, wildness of youth, love of distinction, of country, of honour—something, in short, connected with principle or fate—has led him into the military service. But these Swiss have no principle, real or imaginary, but pay. They engage generally for terms of four or six years, and receive a bounty of one napoleon for each year they engage for. This bounty is not paid to them in full upon enlistment, but a portion of it is placed to their credit in their *livret* or book, which every private has in foreign services, and is paid to them at the expiry of their engagements, to enable them to return home from the port of Genoa, to which those serving in Italy are sent free of expense, if they do not choose to re-engage for a new term of years. They receive much higher pay than the native troops. A subaltern in a Swiss regiment in the Neapolitan service has better pay than that of a captain in a Neapolitan regiment. The men receive four *gran* and bread, and the *élité*, or old soldiers who have re-enlisted, five gran per day, and their ration of eight ounces of meat costs but three gran. They are consequently well off as soldiers, are always in good quarters, and under their own Swiss officers; and both at Naples and Rome are undoubtedly fine, well-appointed troops. Scotland formerly furnished the same kind of condottieri to Holland, Sweden, and France; but the advance of industry and manufacture at home, the colonization of America, and the demand of England for labour from the poorer country, extinguished this kind of military service; nor was it at any time so devoid of all connection with principle or chivalrous motives, as the Swiss enlistments of the present day. The Scotch peasant enlisted under his clansman, or the son of his landlord, who, from attachment to the Stewart cause, or difference of religion, or from national prejudice, preferred foreign service to the British, even with inferior pay. The recruiting also for foreign service was unacknowledged and private. But the Swiss government

[1] *Almanach de Gotha for* 1856.

sanctions the demoralizing system, allows the recruiting publicly, and with the same protection and regulation as for a national army; and sells, for the benefit of a few aristocratic families, principally of Bern, who officer these mercenaries, the military services of her young men to support the most arbitrary governments in Europe. The Protestant republic of Bern furnishes one regiment entirely for the service of the king of Naples; and even in the Pope's body-guards there are Protestants from Bern and other Protestant cantons. No government can set principle at defiance with impunity. These men return to their little spots of land, devoid of religious habits or feelings, or attachment to any religious faith. This service keeps up through the whole population of Switzerland principles and conduct adverse to religious character. The men who thus enlist to pass their youth in the most vicious and bigoted cities in Europe, Naples and Rome, are not the refuse of their country, but the sons of respectable peasants, who are to return to their little heritages and marry, and settle as fathers of families.

Ottoman army.

At the period when the Ottomans first became formidable to Europe, they may be said to have composed one immense army. Every Osmanli was a soldier, and from the age of sixteen to sixty held himself at the disposal of the state; whilst all were animated with a martial fanaticism, which in fact constituted the main sinew of their strength. They were brave, ardent, enterprising; and if their services in the common cause (which they could not withhold as long as they were able to bear arms) remained unpaid, they were not unrequited. A third of the conquered land was distributed amongst them, and held on the tenure of military service; the peasantry cultivated the fields thus ceded to the soldiery, and paid the rents to their military landlords; and the holders of the *ziamets* and *timars*, or greater and lesser grants, received from the fund of conquest rewards proportioned to their services. But this system, although it placed a large numerical force at the disposal of the chief, was nevertheless attended with serious inconveniences. It created a sort of feudal militia, but was incompatible with the existence of a permanent force; it supplied means for a short expedition or campaign, but a continued series of operations was constantly liable to be paralyzed by the soldiers returning to their homes while these were still in progress. To obviate this evil, it was resolved to raise a body of mercenaries, whose services should be at all times available. Accordingly, Sultan Amurath, at the suggestion of his vizier, claimed as his right the fifth part of the Christian youth captured in Bulgaria, Albania, Servia, and Bosnia; who, being instructed in the law of the prophet, and inured to arms, formed a body of soldiers totally distinct from those liable to serve in virtue of their military holdings, and unconnected with the rest of the empire by the ties either of birth or of kindred. Such was the origin of the Janissaries. Organized into a regular force, at a time when the armies of Christian powers consisted of a disorderly militia, and uniting courage and enthusiasm with a species of discipline, and a blind obedience to the will of their commanders, this powerful body swept all before them, and spread far and wide the terror of the Ottoman arms. Nor did the splendour of their achievements suffer any eclipse as long as Christian captives could be obtained to fill the vacancies in their ranks. But when the Janissaries ceased to form a class distinct from the great mass of the nation—when they were allowed to marry and enrol their children—and when the *odas* or regiments became encumbered with men who preferred inglorious ease in the bosom of their families to the toils and dangers of the battle-field—they at the same time ceased to be formidable to their enemies; and, like the prætorian cohorts of ancient Rome, were dreaded only by their emperors. They could raise an insurrection in the capital, demand the head of an obnoxious vizier, and depose or murder an unpopular Sultan; but "the yellow-haired Giaours" had learned to despise them in the field; and, in their degeneracy, they seemed destined to accelerate the ruin of that empire which, in their better days, they had contributed so largely to extend and consolidate.

On this class of men, however, did the Porte, until recently, depend in a great measure for defence against its enemies; and although their inefficiency was daily becoming more apparent, and reform more necessary, every attempt to effect a change of system, and regenerate these Osmanli prætorians, had proved either abortive or disastrous. In vain did Selim try to remodel them, and restore discipline. The attempt cost him his life. In vain did Mahmoud, on his accession, manifest an intention to enforce the regulations of Suleiman the Magnificent. An insurrection was the consequence. During three days the streets of the capital ran with blood; and the Sultan, in order to save his own life, was obliged to command the execution of his brother. But Mahmoud was not of a disposition to be daunted by this failure, although it induced him to change his mode of proceeding. He now saw that nothing less than the complete destruction of the Janissaries would enable him to improve the condition of his empire by carrying through the reforms which he already meditated; and he waited patiently until he could strike the blow with a certainty of success. In 1826 the Janissaries, who perceived the storm gathering, again mutinied. But it was now too late. They found the Sultan prepared for them; and, in raising the cry of insurrection, they only gave the signal for their own destruction. The artillery-men and other troops, faithful to Mahmoud, surrounded them in the Atmeidan; they attempted to defend themselves, but without success; 20,000 perished in the conflict; and the Janissaries as a body were from that moment annihilated. This achievement, though accomplished at a terrible sacrifice of life, was in reality an act of humanity as well as of sound policy; and, viewed in its proper light, it reflects equal honour on the wisdom and firmness of the Sultan, who planned so judiciously, and executed so vigorously, a measure full of peril in itself, yet absolutely indispensable as a preliminary step to improvement of any kind.

The suppression of the corps of Janissaries having left Mahmoud at liberty to remodel his army conformably to the principles of European science and tactics, he hastened to supply the void occasioned by the destruction of the force to which the country had hitherto trusted for its defence; and orders were immediately issued directing the enrolment of a certain number of men in every province of the empire, excepting Albania, Bosnia, and the African states. But the Sultan experienced greater difficulty in raising new troops than he had probably anticipated; for, although the law which places the services of every Moslem at the disposal of the Sultan existed in full force, it applied only to a state of war; and on no previous occasion had such a system of enrolment been resorted to during time of peace—a circumstance which rendered it exceedingly obnoxious to the populace. Another obstacle to the speedy reconstruction of the army consisted in the necessity of excluding from the new corps all persons suspected of what may be called *Janissarism;* and as it had been customary for every Moslem, on attaining the age of manhood, to inscribe his name in some oda or regiment of Janissaries, the only method by which Mahmoud could hope to secure his troops from the contamination of that proscribed sect was by enrolling none but boys in his army. But the adoption of such a plan necessarily created a proportionate difficulty in filling the ranks; while, to add to the embarrassment of the Ottoman reformer, the new system had scarcely been twelve months in operation when Russia declared war against the Porte. That this was a politic proceeding on the part of the Muscovite government no one can doubt. Mahmoud was caught in the very act of transition from a bad system

Army.

to a better one; the regiments of the Ottoman army were still incomplete; and the unpopularity of the contest, with a dread of the Russian arms, acted as an additional check to enlistment, and thus aggravated the evils with which the Sultan had to contend. The new troops were, however, brought into action. They were as yet too ignorant of the advantages of discipline to benefit by the instructions they had received; their manœuvres served but to confuse them; the officers were superior to the men only in name, and the generals were equally destitute of talent; the interior organization of the army was lamentably defective; and the troops had but little confidence either in their officers or in themselves. Yet, with all these disadvantages, the first campaign terminated favourably for the Turks; and it cannot reasonably be doubted that the second one (that of 1829) would have had a similar result, if the Osmanlis had been commanded by a man possessed even of ordinary military talents and enterprise. The grand vizier was unquestionably a brave man; and unlike Yusuff Pasha, he was faithful as well as brave. But, with 40,000 regular troops, superior to any that the Porte had ever sent into the field, he allowed himself to be surprised at Kiulewtscha, or Kuleftscha, and, having lost more than the half of his force, was compelled to retire to Shumla with the remainder. The succeeding events of the campaign were the natural corollaries of this disastrous battle.[1] Turkey was compelled to a very humiliating peace at Adrianople. A manifest improvement after this took place in the Turkish army. In 1853 Omar Pasha, at the head of 150,000 men, defied the Russians on the banks of the Danube. The Sultan Medjid—the most enlightened Turk that ever sat upon the throne; devoting his attention to reforms in all branches of the state, even to the infraction of the ancient Mohammedan laws—endeavoured to raise the army above the influence to which it was exposed by the rapacity or the imbecility of pashas. His efforts succeeded to the extent of introducing a higher state of discipline, and inspiring the Osmanli soldier with a cordial devotion to the interests of the state.

The battles of Oltenitza and Giurgevo demonstrated the zeal and intrepidity of the troops in the field; and the defence of Silistria, and, subsequently, of Kars in Asia Minor, attested their valour and firmness, their patience and constancy behind the walls of a fortress.

The Ottoman army is composed of regular and irregular infantry and cavalry, a corps of artillery, and a regiment of bombardiers or miners. The *Assakiri Monsurei Mohamediyes*,[2] or regular infantry, are said to amount to 50,000 men, of whom 10,000 compose the imperial guard, quartered in and around Constantinople. They are recruited from the mass of the people without distinction; and although neither Mahmoud nor his successor, Abdul Mesjid, obliged the children of his nobility to enter into the service, yet, at the beginning of the present war with Russia in 1853, many enlisted voluntarily, and even some of the Ulemas, or expounders of the law, forsook their peaceful profession and enrolled themselves. The black and white subjects of the Sultan are alike received as soldiers; and in a single regiment may be seen every shade of "the human face divine," from the jet black complexion of the Ethiopian or Nubian, to the white-visaged inhabitant of Rumelia.[3] Once enrolled, a soldier is obliged to serve for life; but it frequently happens that discharges are granted. The regular troops are organized on the model of the French army, and are divided into corps d'armée, divisions, brigades, and regiments. The corps d'armee is commanded by a seraskier, the division by a pasha of three tails, the brigade by a pasha of two tails, the regiment by a miri-alaÿ or colonel, and the battalion by a bimbashee or chef-de-bataillon. A regiment consists of a regimental staff (including the miri-alaÿ or colonel, the caimacan miri-alaÿ or lieutenant-colonel, and the alaÿ-eminy or major) and three battalions, each composed of one bimbashee or chef-de-bataillon, one sagh-col-aghassy or adjutant-major, one sol-col-aghassy or adjutant, 8 yuzbashees or captains, 16 mulazims or lieutenants, 32 tchiaouches or serjeants, 48 on-bashees or corporals, and 720 men—making a total of 2484 officers and soldiers, exclusive of a drum-major, an imaum or chaplain, and a kiatip or clerk. The inveterate prejudices of the Moslemin against the employment of European officers in the service prevented Mahmoud from placing any foreigners in command of his troops, and these were disciplined, partly by officers who had served under Selim in the Nizam Djedid, partly by persons sent from the Egyptian army; but the recent war with Russia has compelled the Turk to yield to circumstances, and Abdul Mesjid, the reigning Sultan, has sanctioned the officering of a large force by Europeans, chiefly Englishmen. The Ottoman officers, taken from the same class of society with the common soldiers, differ from them in nothing but rank and name: in the Turkish army there is no one to look up to, no natural aristocracy created by superiority of condition and of knowledge: the same ignorance and the same prejudices pervade all ranks: and, having the benefit neither of example nor of models, their progress in discipline has been necessarily slow. The Turks seem to think that performing the manual and platoon exercises with tolerable precision, marching in companies instead of independently, and wearing a peculiar uniform, is sufficient to class them with disciplined troops. But in their anxiety to attain the end desired, they have overlooked some of the most essential means. The soldier, for example, is placed in the ranks before he knows how to march; and provided he goes through the manual and platoon exercises, it matters not whether his carriage be steady or the reverse. When in the ranks, the men talk and laugh without restraint, and even address themselves to their officers; whilst the latter, instead of checking, encourage these improprieties, by joining in or retorting the rude ribaldry of the troops. Field officers are, indeed, treated with the most obsequious respect by their inferiors; but the line which has been drawn between the privates and subaltern officers is by no means sufficiently distinct; and it is easy to perceive throughout, that the hand of a master is wanting to combine all the elements of discipline, which are now but imperfectly understood, and to impress upon the higher ranks the necessity of studying their profession, in order to qualify them for discharging the duties of command, as well as to ensure the respect and obedience of the troops.

The Turkish *cavalry* had so long been celebrated for its gallantry and enterprise, that the policy of remodelling it seems exceedingly questionable. This, however, has been attempted, though, as it appears, with very indifferent success. The only regular cavalry in the empire are mounted and equipped in the European fashion; but the horses are small

[1] Trant's *Narrative of a Journey through Greece* in 1830, p. 364, *et seq.* We take this opportunity of acknowledging our obligations to Captain Trant's work for a very considerable portion of the details respecting Sultan Mahmoud's military reforms. There are many points in regard to which it could have been wished that Captain Trant had been somewhat more specific; but on a subject where exact information was not easily attainable, military men ought to be grateful for what this respectable officer was able to collect concerning it.

[2] Literally, "victorious troops of Mohammed."

[3] "Ah!" said a Janissary to Captain Trant, while observing a body of troops marching past, "What kind of soldiers are these? You see every race and every colour on earth amongst them!" "Granted; but martial qualities are not necessarily connected with colour; and discipline, if rigorously enforced, will in time mould even these variegated elements into a fine and formidable army."

in size, ill-conditioned, and badly groomed;[1] and the men find so great difficulty in accommodating themselves to the European method of riding with long stirrups, that their seat is loose and ungraceful; and they are not unfrequently thrown from their saddles to their own infinite mortification. The scimitar, so effective in the hand of a Turk when mounted in the fashion of his country, has also been exchanged for the French light-dragoon sabre; a weapon so differently balanced from that which the Osmanlis have long been accustomed to handle, that they are not likely soon to acquire much dexterity in the use of it. These changes, in fact, seem the very wantonness of innovation; for whilst they have destroyed all that is national or characteristic in this description of force, they have substituted nothing effective in its stead; and it has been found in the present war that the Sultan sacrificed a superb light cavalry for wretched dragoons. His policy should have been, to leave to the Turks their national horsemanship and their national weapons, and to direct his attention exclusively to field tactics and manœuvres, in order to give unity and effect to those daring charges which they are so admirably fitted to execute effectively in their own way. Without firmness in their saddles or confidence in their weapons, the troops make a tolerable appearance on parade; but in the field they are unable to contend with the worst description of horse to which they may be opposed.

The *artillery* is of two kinds, viz., foot and horse. The topejees or foot artillery are at present 11,000 strong. Their new organization is of very recent date; they are now formed into distinct regiments, and quartered over the empire. The horse-artillery, though in a very inefficient state compared with ours, has made considerable progress in discipline. It is divided into regiments of four troops each; and every troop consists of one captain, three subalterns, 180 men, 180 horse, and 10 guns; thus making the total effective strength of a regiment 786 men, 720 horses, and 40 guns, which are commonly nine-pounders and five-and-a-half-inch howitzers. The officers are supplied with horses by the government; and the forage allowed to each horse is nine pounds of barley and twelve pounds of chopped straw *per diem*. The corps of bombardiers and miners amounts to about 3000 men; but they are still undisciplined, and as ignorant of the scientific as they are negligent of the practical part of their profession; their gun carriages, platforms, and ammunition waggons, being in a very inferior state. The education of artillery-officers has hitherto been much neglected; but a college has recently been established for their instruction in the theory and practice of gunnery; and a good many young Turks are sent to France for a military education.

The irregular army may be said to comprise the whole Mohammedan population of the Ottoman empire; since, as already stated, every Moslem, if required, is obliged to join the army during time of war. The irregular cavalry is raised by the Znaims and Timariots, who hold feudal grants from the Porte on tenure of military service. The irregular infantry is assembled by the pashas and inferior officers in the provinces. Eighty years ago, the irregular cavalry constituted by far the most formidable and effective force belonging to Turkey; but the country whence it was derived having been wrested from the Porte by Catherine II., her enemies now use it with great effect against her.[2] The Khans of the Crimea were most useful tributaries of the Porte, and were at all times ready to take the field with from 40,000 to 50,000 horse of the very best description, considered as irregular troops. Brave, hardy, accustomed to support fatigue and privation, inured to riding from their infancy, and obedient to their leaders, the Crim Tartars formed the main strength of the Turkish armies; and, superior to the Timariots, who had become enervated by peaceful habits, were prepared for all kinds of service, nay, even to encounter the best regular cavalry that could be brought against them. The loss of the Crimea, therefore, and of the enterprising troops it supplied, inflicted a severe injury on the military resources of Turkey. The irregular cavalry is now principally drawn from the Asiatic provinces; but as the Mohammedan population has much decreased, this force is consequently less numerous than formerly. The irregular infantry, called Seimens, is furnished by the pashas, ayans, mousselims, and voivodes; and, during the last war, some regiments so raised received pay from the Porte. The men were drawn from Rumelia and Asia; and it is not a little remarkable, that of those who distinguished themselves most in the field in 1828 and 1829, the majority had belonged to the proscribed corps of Janissaries.

The present strength of the whole Ottoman force, almost all of which is in the field, is, according to the most recent accounts, as follows:—

Regular active army	138,680
Reserve	138,680
Irregular troops	61,500
Auxiliary contingent	110,000
Total	448,860

The military establishments of Turkey have yet, in a great measure, to be created: but the Sultan is indefatigable in urging on improvement to the utmost extent of his crippled means. The only founderies for casting cannon are in Constantinople. They are three in number—one of two furnaces, attached to the military arsenal at Tophana; another, also of two furnaces, near the naval arsenal; and a third of one furnace at Hassquiou, the bombardier barracks. In one of these establishments sufficient metal can be melted to cast from five to seven guns at a time; but in all, the tools are of the coarsest description, and everything is effected by manual labour, without the aid of machinery. The workmen are Turks and Armenians; the superintendent an American. The military arsenal at Tophana contains a large stock of artillery of various calibres, and some of extraordinary length.[3] The field pieces are in tolerable order, but the guns have neither sights nor scales. Schools or colleges of medicine,[4] of the marine, of music, and of military instruction, have been for some years established at

[1] This may seem singular, considering the ideas generally entertained of Turkish horses: but, in the first place, these are very much exaggerated; and secondly, the government was obliged to purchase horses wherever they could be found—in Asia, Rumelia, and Wallachia. The best horses belong to the irregular cavalry.

[2] During the campaign against Russia in 1826, the Turks had generally bad information, frequently none at all, respecting the movements of the Russians; whilst clouds of Cossacks scoured the country in every direction, cut off the Ottoman *éclaireurs*, explored all the routes and even bye-paths, and conveyed to headquarters prompt intelligence of the slightest movement on the part of the enemy. It was this entire command of the communications which gave Diebitsch so great a superiority during the latter part of the campaign, and enabled him to surprise the vizier at Kiulewtscha, to mask the celebrated march by which he turned the barrier of the Hæmus, and to acquire for himself the well-merited distinction of Zabalkansky, or Passer of the Balkan. The troops sent to intercept him in the mountain gorges arrived too late, and Zabalkansky was thus enabled, with a handful of troops, to dictate peace in the ancient capital of the empire.

[3] Near the seraglio are several enormous guns carrying stone balls like those fired at our fleet when passing the Dardanelles in 1808. But cannon of this description can only be discharged with effect when the object passes their line of fire, as they are not mounted upon carriages, but built in a wall. Some of the guns at the Dardanelles carry balls 26½ inches in diameter.

[4] There was nothing in Turkey which stood more in need of reform than the healing or rather the killing art. With all their predestinarian prejudices, the Osmanlis place unbounded faith in the skill and knowledge of physicians; and although they have been at all times ready to acknowledge the superiority of Europeans in the science of medicine, they have nevertheless for the most part been

Constantinople. Between three and four hundred young men are instructed at the military school, which is under the superintendence of the chief bombardier, in mathematics and the principles of fortification and gunnery; and some few French works upon military subjects have been translated into Turkish for the benefit of the students. Sultan Mahmoud also established a kind of commissariat department, under the control of the Asker Naziry̆ or superintendent of the troops; and Turkey now boasts of good military hospitals under competent management. Great progress has been made in reforming the pay department, in which enormous abuses formerly prevailed; the troops and the Sultan having been alike plundered by the knaves intrusted with this important branch of the public service. But since the management of the finance, commissariat, and general organization of the army, has been vested in the Asker Naziry̆, conjointly with the seraskier and other high official persons, matters have been placed on a much better footing.

The barrack department in Turkey is extensive. Whichever way one turns the eye at Constantinople, it is almost sure to rest upon a great barrack. These buildings are numerous and imposing, if not in their architecture, at least in their size and spaciousness. Sultan Selim, when attempting for the first time to form a Turkish army disciplined in the European manner, erected several extensive buildings for the accommodation of the Nizam Djedid, or new troops; but when the Janissaries got the better of him, they knocked down most of these buildings. Sultan Mahmoud was the great barrack-builder. Abdul Medjid has added only one or two to the number. Taking into account the vast barracks of Mahmoud at Daoud-Pasha outside the city, the immense barracks in the Asiatic suburb of Scutari, and the barracks and commodious guard-houses on either side of the Bosporus, 100,000 men might be lodged here without much crowding. In the spring of 1848, several of these great barracks were entirely empty, and there were others that had but few inmates. More than one, which had cost Mahmoud immense sums in 1828, were already neglected, and showing symptoms of decadence. The artillery barracks just outside the Pera suburb, were erected by Sultan Selim, and upon plans and designs furnished by Count Sebastiani and General Andreossy. They are well situated; they are imposing in their extent, and seem to be in all respects well suited to their purpose. The entire barracks could comfortably hold from 3000 to 4000 men. They are exceedingly well ventilated. The distribution of the apartments or wards is excellent. In each long room there are two double rows of mats, each row accommodating about 55 men. The mattresses and bed-covers are stowed away in the middle of the room, in an open wooden screen which occupies very little space; they are neat and clean, and very well arranged. At night the mattresses are spread over the matting of the floor. Bedsteads are dispensed with, except in hospitals. But hardly any Turks think as yet of using bedsteads, or of setting apart rooms merely as bed-rooms. In the best houses they sleep on the broad divans, or spread their mattresses on the floor. In the morning the servants come in, and walk away with the beds; and then the room where you have slept becomes a drawing-room, or a dining-room, or both in one. During the day, bed and bedding are deposited in presses or cupboards. Mr Macfarlane, who visited Turkey three or four years since, writes—"The artillerymen's mattresses are at least as good as those we generally slept upon; as usual, the most slovenly feature was in the shoeing. In the corridor, at the door of every barrack-room, there was a multitudinous array of muddy, filthy boots and shoes, through which it was not always easy to steer one's way without tripping. The soldiers must not enter the rooms with their shoes or boots on. These are thrown off at the door: if the men have slippers they put them on; if they have not, they must walk on the soles of their socks. But the same rule obtains everywhere: there is no walking a hundred yards without being covered with mud in winter, and dust in summer; and then the Mussulmans, with almost the strictness of a religious observance, consider their carpets and mattings as things to be trodden only by clean slippers or bare feet. At the foot of the main staircase of every much-frequented Turkish house, we invariably found a confused heap of mud-boots, dirty boots, and shoes. It was so at Ali Pasha's. When the staircase happened to be a dark one, I never could help blundering among some such heaps. The effect was very disagreeable to other nerves besides the olfactory. A very little care and arrangement would obviate it; but it is *adet*, old custom.

"The officer in command at the artillery barracks—one of the many Achmet Pashas—was civil and rather communicative. He agreed that the whole appearance of the soldiers would be much improved if they were better shod, and would make use of brushes and a little blacking. Their present process of cleaning boot and shoes (when they clean them at all) is to rub them over with birch brooms, and then wash them in cold water. Shoe-leather neither washes nor *dries* well; and hence many bad colds and coughs. There was not a jacket nor a pair of trousers in barracks but sadly needed beating and brushing. The best of the artillerymen look dirty and negligent in their persons. A neat old English or Austrian soldier is far cleaner and more tidy in coming off a long and rough campaign, than these Turks, who are hardly ever moved from their barracks. Achmet Pasha treated us to pipes and coffee, and to the sight of some horse-artillery exercise and manœuvres. The guns were all brass; the carriages were all painted with a very light green paint, which had a bad and very mean effect. Neither guns nor carriages were kept clean. The harness was abominably dirty. The horses were all white or very light grays; they told us that they were bred in Rumelia, in the country up above Phillipopoli; I was much deceived if they were not all Transylvanian or Hungarian horses—they bore a very close family resemblance to a breed I had often admired in the Emperor of Austria's army. They were what we should consider under-sized for that service; but they were compact and strong, and not at all deficient in spirit; they were well broken into their work, were admirable in hand, and the artillery drivers drove them in good style. About a dozen light field-pieces were very well handled in an inclosed field in front of the barracks. It was by far the best specimen of military exercise we saw in Turkey: but the Pasha showed us only his very best men. The instructing officer was a German, who had been a serjeant of artillery in the Prussian service. A few young Turkish subalterns seemed both active and intelligent; but the superior officers were sitting down on stools, looking on, and smoking their tchibouques. The Mahmoud barracks over at Scutari, though wanting elevation, are truly magnificent in length and breadth, and in situation. Take them altogether, they are the finest barracks I ever saw in any country.

"Before the conflagration the barracks could lodge from 6000 to 7000 men. There were now in it two regiments of infantry, one regiment of artillery, and a few squadrons of cavalry. None of these men had been moved for very many months; during the winter they had hardly quitted their barracks. The cavalry were all lancers, and so in-

obliged to intrust the welfare of their bodies to empirical adventurers, whose knowledge had been acquired much in the same manner as that of the learned hakim Yacoob, so admirably described in "Anastasius." Recently the British government has sent out a gentleman who had much distinguished himself as professor of the Calcutta Medical College, to organize a similar college at Constantinople.

deed were all the horse-soldiers we saw of this new regular army. We heard of dragoons and of corps of heavy cavalry; but we never saw a single specimen of either. They had no horses in the country fit to mount a heavy regiment. The pasha sent one of his officers to conduct us over the barracks. Here, where there had certainly been no preparation or previous notice, there were some few signs of slovenliness and negligence; but, on the whole, one might fairly say the barracks were in excellent order. The stables, like all the Turkish stables I ever saw, were decidedly bad. They would have thrown an English or an Austrian dragoon into a passion. Soldiers who will not beat and brush their own jackets are not likely to bestow much pains on the coats of their horses; we never saw a trooper's horse look as if it were groomed. I believe these lancers of the imperial guard were entirely innocent of the use of curry-combs and brushes. What with the natural slovenliness of the men, and the rough and dirty appearance of the horses, a regiment of lancers when united presented but a shabby picture—a picture to excite derision on any parade or drill-ground in Christendom. Some of my Frank friends argued that this outward and visible show would not affect their fighting qualities. *J'en doute.* A good soldier is always a clean soldier; it is by cleanliness and the care of his groom, as well as by good food, that the trooper's horse really becomes a war-horse. The fellow who is so lazy that he will not clean his own boots is the very man to be negligent of more important duties. In an excellent, open, extensive drill-ground, offering the most glorious views of Constantinople, the Propontis, the islands, the Asiatic coast, and the snow-covered summits of Olympus, we saw some infantry being drilled by Turkish officers, who, for the most part, seemed very much to stand in need of drill themselves. It was slow and slovenly work, but conducted with great calmness and good-humour. The Sultan insists that there shall be no beating, no cruelty or harshness. There certainly was none *here;* nor did I ever see any at Constantinople, except once, when a hideous-looking Nubian officer was drilling some white Turkish recruits in the broad galata moat, and soundly thrashing the dull ones with a country riding-whip made of buffalo's hide. Part of a regiment which had fulfilled its term of service, but which was kept together, and very incorrectly called a *militia regiment,* marched across the drill-ground, and went to perform some light infantry movements on the gently sloping hills between the barracks and the grand cemetery of Scutari. These men were neater and cleaner than the infantry in the barracks, from whom they were distinguished by wearing the black cross-belts instead of white. They trod over the ground with a good light step, and their evolutions *en tirailleurs* were quick and good. But here again was the alloy, the canker of Turkish indolence: half of the officers, instead of marching at double-quick time over the hills with their men, remained behind on the drill-ground to gossip and smoke pipes with the officers there. Several of the smaller barracks we visited were deserving of all praise for order and cleanliness; this was particularly the case with those on the Bosporus at Arneoutkeni, Bebek, and Roumeli Hissar. To the spacious barracks in Constantinople Proper, which stand round the Seraskier's Tower, I was refused admittance. I believe that this refusal was owing to my having expressed a too eager wish to see the Seraskier's Prison, which stands within the same great inclosure of lofty walls. Externally the barracks looked neat and clean; they are very extensive, and admirably situated on the summit of one of the seven hills of Constantinople. Nearly every recent writer of travels in Turkey has dwelt upon the magnificence of the views from the top of the lofty tower of the Seraskeriat. We rather frequently passed the great inclosed square of the Seraskeriat; but although here were the headquarters of the army, we seldom saw the soldiers doing anything. But one afternoon, in the month of March, when the French revolution of 1848 had startled the Porte out of an easy slumber, we witnessed a great show of activity in the square. About 1500 men were exercising under the eye of a fat pasha (name unknown to us), and the great seraskier himself was looking on from a distant window, with a tchibouque in one hand and an eyeglass in the other. The majority of these men were not young recruits, but soldiers of some standing; yet their performance was rather loose and slovenly. When they formed in line, their line was far from being a right one; their formations into squares, hollow and solid, were but poor exhibitions. The men all looked slip-shod, and dreadfully dirty about the feet. With such shoes as they wear it is scarcely possible for them to march well; they might as well try it in their old unheeled paprashes. Many of the men would have been, in better hands, excellent materials for soldiers, being broad-chested and altogether well-made fellows.

"From this time exercise and military evolutions became rather frequent at the foot of the tower of the seraskier. At first the Turks chuckled over the troubles and disturbances of Christendom, but it was not long before they became apprehensive that these convulsions might bring about consequences and political changes that would be very fatal to their empire. If they rejoiced when the revolutionary principle reached Vienna, and when Kossuth and anarchy raised their heads in Hungary, it was but for a moment, and only out of the souvenir that the Austrians had been old enemies of the Osmanlis; and very soon they seemed to feel instinctively that, should any power be gained by the Czar, and any very serious injury be inflicted on the Austrian empire, the Ottoman empire would lose one of the best props upon which it leaned. Some of them talked big; but misgivings and fear were in their hearts. In their ignorance, or very insufficient information, they went on rather rapidly to the conclusion that it was all up with Austria; that Russia would soon have the entire command of the Danube, and would thence recommence war upon Turkey. The panic was, of course, increased when insurrection broke out in their Danubian principalities of Moldavia and Wallachia, and when Russia, claiming her indisputable right to interfere—a right recognized in successive treaties—began to march troops towards Jassy and Bucharest. In the months of May and June they had *exercises à feu* two or three times a-week at the Seraskeriat. If not decidedly bad, the firing was certainly not good. The Dadian's powder was detestable; the muskets were very bad, with the old flint locks. Hardly any of the regiments had percussion locks. The bursting of musket-barrels, with the catastrophes attendant thereon, were alarmingly frequent. Before long it may be very important that England should have a correct notion of the value of this army. I would not underrate it, but I feel confident that, alone, it could never stand in the field against the veteran troops of Russia; and that, unless Christian officers were put in the command (as we placed British officers over the Portuguese), they would be very inefficient and troublesome auxiliaries. A French officer—who had studied them well, who had lived long in the East, and who was also perfectly well acquainted with the Russian army, said that it was the most idle of dreams to fancy that this imperfectly disciplined army of Abdul Medjid could meet the troops of the Emperor Nicholas in the field. He considered that the degree of discipline to which they had attained did not compensate for the loss of the fanaticism and enthusiasm which animated their undisciplined predecessors; that they might make a stand, and fight pretty well behind stone walls; but that *en rase campagne* they would fall like wheat before the reaper's sickle, or go off like chaff before the wind. '*Ils n'ont point d'officialité;*' they have hardly any competent officers. As you ascend the scale of rank, instead of finding more science and experience, you usually find more

Army.

ignorance and inexperience. Generally the great pasha, placed by court intrigue at the head of an army, has never been a soldier, and is in military affairs about the most ignorant man in that army. He takes some officer into his favour, and relies for some time on his judgment and advice; then he changes, and takes another adviser; or, if his difficulties become at all complicated, he will seek advice of a dozen men, who may very probably entertain twelve different opinions and plans. Fancy, then, the jumble of every operation! In their intolerance or their pride, unless a Frank officer turn renegade, they will not allow him to exercise any command—they will not even permit him to wear a sword—he can be only a despised instructor, little more than a good drill-serjeant—he may or may not be well paid, but he cannot take real rank as an officer, or in fact be a part of the army. Here and there you may find a Polish, German, or Italian renegade, usually a deserter and a scoundrel. Hardly one of these fellows has ever been more than a non-commissioned officer in his own country; here they suddenly become captains, majors, colonels. These are the men the great pashas prefer. Low-born and low-bred, they can submit to Turkish arrogance, and to treatment which no gentleman can possibly tolerate. One may conceive how competent are these renegades to the conduct of an army in the field. Then, who would answer a single hour for the honour or common honesty of such a *canaille*? They have deserted their colours, they have deserted their religion; let Russia, or any other assailant of Turkey, tempt them with a good bribe, and they will desert the Sultan and sacrifice his troops."[1]

Since this was written, the Sultan has consented to the formation of a contingent, 20,000 strong, commissioned and officered by Englishmen; and there seems to be every probability of its proving a most efficient force. It consists of regulars and irregulars, the latter being for the most part Bashi-Bazouks from Asia Minor.

Greek army.

The reforms effected by Sultan Mahmoud in the military organization of the Turks rendered it expedient for the Greeks to attempt to form regular corps, in order to keep on a level with their enemy in point of discipline and tactics. Accordingly, on the 27th February 1827, the president ordered a military force to be organized in regiments (*chiliarchies*) of two battalions (*pentacosiarchies*), divided into five companies (*hecatoncharchies*) each; a regiment to consist of a colonel (*chiliarch*), two chefs-de-bataillon (*pentacosiarchs*), 10 captains (*hecatontarchs*), 20 lieutenants (*pentacontarchs*), 40 sub-lieutenants (*eikosi-pentarchs*), 80 serjeants (*dodecarchs*), 160 corporals (*pentarchs*), and 800 soldiers—in all 1122 men. Another decree ordains the formation of a battalion of artillery of six companies, with a suitable cortège of officers; and embodied in it a sort of provisional code of military law. Since Greece has become a monarchy under European protection, a small standing army has been organized, consisting of 8600 men and officers.

American armies.

The American armies require only a very cursory notice. That of the United States, exclusive of militia, amounts to little more than 10,000 men. It consists of eight regiments of infantry, four of artillery, one corps of engineers, two regiments of dragoons, one of horse fusiliers,[2] and a sort of general staff; and it is formed into three divisions, each under the command of a general officer. The republicans of the West have a great aversion to a standing army, and only maintain a sort of skeleton, to be filled up, in case of need, from the militia force. On 1st January 1854 the commissioned officers of the regular army amounted to 952, the non-commissioned officers and privates to 9377, being in all, 10,329 men. The militia in 1854 consisted of 758 general officers, 2407 general staff-officers, 13,787 field officers, &c., 49,337 company officers, and 2,054,740 non-commissioned officers, musicians, artificers, and privates, being 2,259,037 in all. The troops of the United States excel in bush-fighting; but they have neither organization nor discipline, and on any other soil than their own would be anything but formidable.—The Mexican army has been much reduced since its reorganization under the law passed on the 4th of November 1848, and in 1849 did not number more than 5200 rank and file in actual service.[3] In 1850 the actual armed force consisted of—infantry of the line, 3632 men; cavalry of the line, 1507; artillery, 658; active militia, 232; sappers and miners, 303; soldiers at military stations, 1282; national guard, 1295—total, 8909 men, with 520 officers. The black army of Hayti consists of the emperor's guard, with the infantry and artillery of the line. The guard, which ranks at the head of the army, consists of two regiments of infantry, one of grenadiers, and the other of chasseurs; and three regiments of cavalry, one of carabineers, one of grenadiers, and one of chasseurs. There are 33 regiments of infantry of two battalions each, and every battalion has six companies, viz., one of grenadiers 80 strong, one of chasseurs 50, and four of fusiliers 44 men each. Attached to this infantry, and distinct from the guard, are two regiments of dragoons of two squadrons, divided into two companies of 70 men each. The artillery consists of five regiments of two battalions, divided into nine companies of 50 men each, including officers. There is also an engineer corps, with 26 companies of 50 men each of artificers and pioneers. The whole of the Haytian force, therefore, including the staff and the president's guard, amounts to about 26,000 or 27,000 men.—We are not in possession of any accurate details respecting the composition and force of the various South American armies. The Brazilian is estimated at from 35,000 to 40,000 men, including militia; the Colombian or Venezuelan at from 15,000 to 20,000; the Peruvian at 20,000; and the Chilian at from 10,000 to 12,000 men of all arms. But these numbers are in a great measure conjectural. The military force of the Argentine republic is probably not greater than that of Chili or Venezuela; while that of Paraguay amounts to about 5000 regulars and 20,000 militia.

British army.

From time immemorial the inhabitants of the British Islands have been distinguished for a determined bravery, united with a degree of physical power, which belongs to the people of no other nation; and hence, as soldiers, they have never yet, when properly commanded, found their match in the field of battle. "L'Angleterre," says Count Turpin, in his commentaries on Montecuculi's *Mémoires*, "est elle peut-être la nation où la bravoure se soutient depuis le plus long temps." "Our nation," observes Dr Johnson, "may boast, beyond any other people in the world, of a kind of epidemic bravery, diffused equally through all its ranks; we can show a peasantry of heroes, and fill our armies with clowns whose courage may vie with that of the general." The valour of a Briton is innate. It is a national instinct, co-existent with and inseparable from the man himself, and requiring no artificial excitement to bring it into action; and it is as powerful at the present moment as it was in the chivalrous days of Cressy, Poictiers, and Agincourt. Hence, although the fortune of our arms may have varied, the character of the soldier has always remained the same; and at Waterloo as at Blenheim, and Ramilies, and Malplaquet, he established his superiority in all those high military qualities which render a nation invincible. But, from various causes, the reputation of the British army,

[1] Macfarlane's *Travels in Turkey*, 2 vols. 8vo. London, 1847–48.
[2] Fraser's *Resources of all Nations*.
[3] Mayer's *Mexico*, vol. ii., ch. x.; Hartford, 1852.

which the campaigns of Marlborough had raised to the highest pitch, and which the various actions of the Seven Years War had gloriously sustained, began subsequently to decline; while the disastrous results of the American revolutionary war created an opinion, which succeeding events appeared to confirm, of its total unfitness for prosecuting a lengthened series of operations, or contending with any prospect of success against the armies of other nations, particularly those of the Continent. It was conceived to be little better than a body of marines, well qualified to cooperate with the navy in partial expeditions, or in making descents on the sea-coasts of any country with which Great Britain happened to be at war, but incapable of maintaining itself in the field, or of engaging in regular campaigns; and to say the truth, there were not wanting plausible reasons which might be alleged in support of such an opinion. For, as if they had been determined, not merely to countenance this impression, but really to render the army as inefficient and as utterly destitute of consistence and energy as it was generally believed to be, the British ministry persisted for a series of years in wasting its strength in paltry expeditions, or in effecting partial descents upon this or that country, instead of combining one great effort calculated to influence the general result of the contest. Yet, in 1795, the regular army, including the force under the Duke of York in North Holland, exhibited a total of 119,000 men, besides about 42,000 employed in the colonies, in Corsica, in Gibraltar and India; a force which, directed with skill and judgment, might have saved the country from many humiliations, prevented an enormous accumulation of debt, and accelerated the termination of a sanguinary and ruinous contest. The campaign of Egypt in 1801 showed, it is true, some small degree of energy, and, above all, afforded the army an opportunity of proving its undiminished excellence. But, unfortunately, on the renewal of the war in 1803, the old system was resorted to, and all the prejudices which had previously existed against the army were revived with tenfold force—prejudices which outlasted the first successes of the Peninsular campaigns, and were only at length overcome by an unexampled series of victories, obtained over the ablest general and the best troops of which France could boast.

"The French army," says Sir William Napier, "was undoubtedly very formidable from numbers, discipline, skill, and bravery; but, contrary to the general opinion, the British army was inferior to it in none of these points save the first; and in discipline it was superior, because a national army will always bear a sterner code than a mixed force will suffer. With the latter the military, not the moral crimes, can be punished. Men will submit to death for a breach of great regulations which they know by experience to be useful, but the constant restraints of petty though unwholesome rules they will escape from by desertion, or resist by mutiny, when the ties of custom and country are removed; for the disgrace of bad conduct attaches not to them, but to the nations under whose colours they serve. Great, indeed, is that genius that can keep men of different nations firm to their colours, and preserve a rigid discipline at the same time. Napoleon's military system was, from this cause, inferior to the British, which, if it be purely administered, combines the solidity of the Germans with the rapidity of the French, excluding the mechanical dulness of the one, and the dangerous vivacity of the other; yet, before the campaign in the Peninsula had proved its excellence in every branch of war, the English army was absurdly underrated in foreign countries, and absolutely despised in its own. It was reasonable to suppose that it did not possess that facility of moving in large bodies which long practice had given to the French; but the individual soldier was (and is still) most falsely stigmatized as deficient in intelligence and activity, the officers ridiculed, and the idea that a British could cope with a French army, even for a single campaign, considered chimerical. The English are a people very subject to receive and to cherish false impressions. Proud of their credulity, as if it were a virtue, the majority will adopt any fallacy, and cling to it with a tenacity proportioned to its grossness. Thus an ignorant contempt for the British soldiery had been long entertained before the ill success of the expeditions in 1794 and 1799 appeared to justify the general prejudice. The true cause of those failures was not traced, and the excellent discipline afterwards introduced and perfected by the Duke of York was despised. England, both at home and abroad, was, in 1808, scorned as a military power, when she possessed, without a frontier to swallow up large armies in expensive fortresses, at least two hundred thousand [1] of the best equipped and best disciplined soldiers in the universe, together with an immense recruiting establishment, and through the medium of the militia, the power of drawing upon the population without limit. It is true, that of this number many were necessarily employed in the defence of the colonies; but enough remained to compose a disposable force greater than that with which Napoleon won the battle of Austerlitz, and double that with which he conquered Italy. In all the materials of war, the superior ingenuity and skill of the English mechanics were visible; and that intellectual power that distinguishes Great Britain amongst the nations, in science, arts, and literature, was not wanting to her generals in the hour of danger."[2]

It is almost needless to add how conspicuously this brave and unequalled army disproved the calumnious prognostications of its contemners and revilers; how gloriously it established, in seven campaigns and more than twenty pitched battles, its superiority over the veterans of France, crowned with the laurels of a hundred victories, and accounted invincible till called to contend with the men of our soil. Let us now direct our attention to its composition and organization.

By the constitution of this country, the Queen is the supreme head and captain-general of the army, which can receive no orders except such as emanate from her, and is bound to obey all her orders, unless at variance with the fundamental laws of the land, in which case submission to her authority would be declared rebellion against the constitution of the state and the nation at large. To her belongs the power of declaring war and concluding peace, of granting subsidies to her allies and indemnities to her enemies; but no treaty is valid or binding unless it be signed by a responsible minister; and without the authority of parliament the Queen cannot touch a sixpence of her subjects' money for this or any other purpose. Further, it is expressly declared in the bill of rights, and annually repeated in the preamble to the Mutiny Act, which forms the martial law of the British army, "that the raising or keeping a standing army in time of peace, unless it be with the consent of parliament, *is against law*;" in other words no military force can be raised or maintained in this country, except with the consent of the three estates composing the legislature, by which, in their collective capacity, the sovereign power of the state

[1] At the period in question the British army consisted of 30,000 cavalry, 6000 foot-guards, 170,000 infantry of the line, and 14,000 artillery; in all 220,000 men. Of these between 50,000 and 60,000 were employed in the colonies and in India; but the remainder were disposable, because from 80,000 to 100,000 militia, differing from the regular troops in nothing but the name, were sufficient for the home duties. If to this force we add 30,000 marines, the military power of Great Britain, at the time referred to, must have exceeded 400,000 men, exclusive of local militia and volunteers.

[2] *History of the War in the Peninsula and in the South of France, from the year* 1807 *to the year* 1814. By W. F. P. Napier, C.B., Lieutenant-Colonel, H. P., 43d Regiment.

is exercised. But in regard to the existing army, all measures and all acts deemed necessary for its regulation, direction, and employment, are decided upon by the Queen in council; and it is the duty of the commander-in-chief of the forces for the time being to direct the execution of such measures or acts, in all those operations which are executed within the United Kingdom, as well as to superintend the organization, instruction, and discipline of the troops belonging to the different branches of the service. A secretary of state is specially charged with the administration of the war department in all its branches. He is the organ of communication between government and the army on the one hand, and between the army and the government on the other; and he acts as a check upon the commander-in-chief, while he is in turn restrained by his responsibility to parliament, to the country, and to the laws.

In the year 1795 a secretary of state for the war department was created, and in the year 1801 the colonial correspondence was transferred to the office. In the first instance, and during the whole course of the war, the principal business of the colonial department was to exercise a general control over all the military departments, the secretary-at-war, the ordnance, and the commander-in-chief; it was one head which directed all their operations to one common end; and as long as the secretary of state made this his principal duty, which was really and substantially the war department, that arrangement was good. The secretary-at-war was then, in point of fact, a sort of subordinate to the secretary of state for the war department. But at the end of the war, the mere military business diminished in importance; and, on the other hand, the civil business of the colonial office was rapidly increased in consequence, because it was found that during the war attention was very much turned away from the civil affairs of the colonies, and that everything yielded to the superior importance of military business. The result of that change after the peace was, that gradually the secretary of state for the war and colonial departments came to exercise less and less control over any details of military arrangements, and his attention came to be more and more occupied in the civil affairs of the colonies. As the extent of correspondence increased, that augmented; and the effect was that for 30 years the military affairs of the country were transacted by three or four different departments, and virtually without any one effective head to direct their measures to one common end. The war with Russia, which broke out in 1854, demonstrated the sad results of this system—so fruitful of confusion and irresponsibility—and the duties of secretary of state for war and the colonies were accordingly separated, the office of secretary-at-war abolished, and the control of military affairs placed entirely in the hands of a secretary of state for war only. This concentration of power and authority was followed by the abolition of the Ordnance and Medical Boards, a complete remodelling of the whole of the war department, and the introduction of a spirit of improvement which is producing the best re-

The departments exclusively military are those of the adjutant-general and the quartermaster-general.

The adjutant-general's department consists of the adjutant-general himself, the deputy-adjutant-general, the assistant-adjutant-general, and the deputy-assistant-adjutant-general, with a number of clerks, &c. The adjutant-general is named directly by the sovereign, on the recommendation of the commander-in-chief, and has the rank of lieutenant-general, though for the most part only a major-general. The deputy-adjutant-general is also appointed by Her Majesty; but the secondary offices of the department are filled by persons nominated by the adjutant-general himself. This officer may be considered as the director of the *personnel* of the British army. Everything relating to the effective or non-effective state of the troops; to formation, instruction, and discipline; to the direction and inspection of the clothing and accoutrements of the army; to recruitment, leaves of absence, or bounties to soldiers; to the employment of officers of the staff; and to ordinary or extraordinary and official returns relative to these different matters, whether required by Her Majesty, by the ministry, by the secretary-for-war, or by parliament, falls within the province of the department over which the adjutant-general presides. He is the regular channel through which commanders of corps communicate with the commander-in-chief; and all orders, special instructions, and general regulations issued by the commander-in-chief, relative to the organization, discipline, or instruction of the army, are prepared, addressed to the commanders of corps, and published by the adjutant-general, conformably to the direction of the commander-in-chief of the forces, acting in the name and on behalf of Her Majesty. The troops stationed in Scotland, however, instead of communicating directly with the adjutant-general's office in London, address themselves to the deputy-adjutant-general who resides at Edinburgh; and Ireland has also a deputy-adjutant-general resident in Dublin. It is also the duty of the adjutant-general to prepare, weekly, for the commander-in-chief and the Queen, returns of the troops stationed in Great Britain and Ireland; and, monthly, for the commander-in-chief, the minister-for-war, and the Queen, a general statement of all the forces both at home and abroad.[1]

The quartermaster-general holds the same rank, and is appointed in the same manner as the adjutant-general. His principal duties are to prescribe routes and marches, to regulate the embarkation and disembarkation of troops, to provide quarters for them, to mark out ground proper for encampment, to execute military surveys, and to prepare plans and arrange dispositions for the defence of a territory, whether such defence is to be operated by the troops alone or by means of field-works. Every British army on service has a quartermaster-general, with assistants, who perform functions altogether analogous to those which are discharged in the department of quartermaster-general of the British forces; and it is admitted on all hands that, during the Peninsular campaigns, this branch of service was, under the very able direction of Sir George Murray, carried to a high degree of perfection. Whenever the army, established for the time in any position whatever, had to move in advance and in a given direction, all the officers of the quartermaster-general's staff, charged with the reconnaissances, immediately set out and spread themselves over the ground, each individual taking the direction indicated to him, and pushing his reconnaissance to the extent of a day's march of the army. About five in the afternoon these officers returned to head-quarters; and by combining their different partial sketches, a general plan was prepared, according to which the quartermaster-general and the commander-in-chief traced the routes to be followed, and the positions to be taken up, by the troops who were to march on the morrow. This was the duty of every day while the army was in motion; and no better evidence can be produced of the ability with which it was performed than the circumstance that, during the whole of the Peninsular campaigns, the army never once took up a position in which it could be assailed by the enemy, however superior in numbers, with the remotest chance of success. Attached to the office of quartermaster-general of the forces is a Topographical Department, with a depôt of maps, plans, and military memoirs,

[1] Dupin, *Force Militaire de la Grande Bretagne*, I. ii., p. 54.

and a library containing the best military works that have been published in different countries.[1]

The barrack department is a numerous one, consisting of barrack-masters, store-keepers, hospital store-keepers, barrack-sergeants, and clerks. Their principal duty is to take care of the barracks for the reception of the troops; and generally see that the troops are properly accommodated, both as to room and otherwise. There are 118 barracks in Great Britain, of which 102 are permanent, and 16 temporary. In Ireland there are 109 barracks, of which 98 are permanent; and in the colonies there are 367 barracks. The number of persons which can be thus accommodated is 150,728 non-commissioned officers and men, and 6218 officers. A report recently sent in to government by a commission nominated to inspect the state of the barrack department has recommended extensive and important changes in the construction and distribution of barrack quarters.

The commissariat department consists of a director of commissariat attached to the War Office, a commissary-general, deputy-commissaries-general, and assistant and deputy-assistant commissaries, all of whom are employed in the colonies, the Mediterranean stations, and on field service.

Their duties consist in supplying provisions and forage to the troops; and in providing the materials of the medical department of the service. Every army on active service has its own commissariat, under the orders of a commissary-general, who is responsible, in the first instance, to the general-in-chief for the regular supply of the troops under his command. In Portugal and Spain, the provisioning of the army was effected by commissaries stationed at different places, or attached to brigades, and paid from funds supplied by the commissary-general of the army, consisting partly in cash and partly in bills or debentures on the English government. Immense abuses appeared to have prevailed in the commissariat department during the early part of the Peninsular campaigns. This is evident from the repeated orders of the day issued by the Duke of Wellington against malversations on the part of subordinates in this department; and not less so from the fact, that notwithstanding all the care and vigilance exercised by his Grace, many of these functionaries managed to realize fortunes.

The medical department of the army is under the superintendence of a director-general, who is on the establishment of the War Office; and a large staff of medical officers, including inspectors and deputy-inspectors general of hospitals, surgeons and assistant-surgeons, is attached to the army. Exclusive of these are a body of purveyors who provide the medical comforts necessary for the troops.

To the chaplain-general of the army is entrusted the providing for the spiritual wants of the soldiers, while the military schools are under the superintendence of an inspector-general; the regimental and garrison schoolmasters being trained chiefly at the military asylum in Chelsea.

A board of military education was constituted in 1857, to conduct the examination of candidates for commissions in the army.

The paymaster-general is the head of the army pay-office, whence the issues for the payment of every description of military service are made. This office consists of the paymaster-general himself, a deputy, a staff of clerks, and other subordinates; and there are several deputy-paymasters abroad subordinate to the general department at home. The paymaster-general has no active control over the expenditure of the public money. His duty is merely to make payments ministerially, and without discretion, in pursuance of the warrants directed to him by the secretary-for-war, the treasury, or both, as the case may be; or in honour of the drafts of the deputy-paymasters abroad, for the ordinary services of the army. The pay-office must therefore be looked upon as an office of account merely, and as affecting the public expenditure only in as far as it performs the duties of an office of accounts with regularity and expedition. The materials and documents, which compose a considerable part of the accounts of the paymaster-general, originate with persons over whose conduct he exercises no manner of control. Indeed, there is a regular succession in preparing them, from the regimental paymaster to the agent, and from the agent to the secretary-for-war, who finally delivers them at the pay-office. Different classes of accounts and documents are delivered in at certain periods prescribed by the pay-office act. But large balances of the public money are not now, as formerly, allowed to remain in the hands of the paymaster-general, or at his credit at the bank; nor can he derive any profit from the custody of the public money, the balances being confined within the narrowest possible limits. The establishment of a regiment, with the royal regulations and warrants, is in fact the instrument which regulates the pay of the army, and is consequently the basis of all the documents which enter or go out of the pay-office under that head of the service.

The department which comprehends the artillery and engineers is administered no longer by a board of ordnance, but is placed under the secretary of state for the war department. Under him are an inspector-general of fortifications, directors-general of the artillery, of stores, of clothing, and of contracts. And each department has a separate head acting under the directors-general, and these are called superintendents. Thus there are superintendents of royal gun factories, of royal carriage factories, of royal laboratories, of the small-arms factory, and of the royal factory of gunpowder. The sums voted for the support of this department proceed on estimates of the ordinary and extraordinary service, and of services unprovided for. So much for the military departments. Let us now attend to the composition of the army itself.

The British army consists at present (1858) of 10,555 cavalry and 119,580 infantry; but of this force, 8217 cavalry and 84,522 infantry are employed in the East India Company's territories. This force is altogether exclusive of the artillery and engineers, &c.

The *Cavalry* on home service consists of the 1st and 2d regiments of life-guards, and the royal regiment of horse-guards (blue), with 25 other regiments of dragoon-guards and dragoons; namely, 7 of dragoon-guards, 3 of dragoons, and 15 of light dragoons, including lancers and hussars, amounting to 9241 rank and file; or, including the regiments of life-guards, 10,555 rank and file. In this enumeration, however, the royal horse artillery, the military train, and the Cape corps of mounted riflemen are not included. The 1st regiment of dragoon-guards consists usually of 438 rank and file and 361 horses; but the remaining regiments of the cavalry of the line at home have only 328 rank and file and 271 horses each; those in the field are from 639 to 674 strong. The officers and non-commissioned officers of a regiment of life-guards, on its present establishment, amount to 85; of a regiment of the cavalry of the line, to between 60 and 70. Thus: 1 colonel, 2 lieutenant-colonels, 2 majors, 8 captains, 8 lieutenants, 8 cornets, 1 paymaster, 1 adjutant, 1 quartermaster, 1 surgeon, 1 assistant-surgeon, and 1 veterinary surgeon; or 35 officers in all, besides sergeants and trumpeters. And the same relative proportion obtains, whatever be the foot-

[1] Dupin, *Force Militaire de la Grande Bretagne*, I. ii., p. 59.

Army. ing, in point of effective force, on which the regiment is placed.

Since the peace of 1815 various changes have been made in the arms and equipments of our cavalry. In the first place, armour was given to the life-guards immediately after they had proved its total inefficiency in the field of battle, and torn the laurels of Waterloo from the redoubted cuirassiers of France. That armour must prove a decided impediment to the efficacy of a dragoon on service, is what no one can for a moment doubt. Its weight,[1] the constant cleaning which it requires, the pain which its inflexibility must occasion under fatigue, and the obstacles it opposes to the free and full action of the muscular powers of the human body, greatly detract from its advantages. These, moreover, have been overrated; and we are much mistaken if it will not one day be shown that the life-guards, encumbered with the cuirasses, are immeasurably less formidable than they were when their natural strength, weight, and activity had full freedom of action allowed them. In the next place, four of our regiments of light horse have been converted into lancers. We agree in opinion with Montecuculi, that the lance "est la reine des armes pour la cavalerie;" and we also think, with Major Beamish, that lancers should constitute the standard cavalry of England. But we do not the less object to the particular kind of lance introduced into our service, and the description of cavalry to whom it has been assigned. No nation possesses such materials as Britain for the formation of redoubtable lancers; no nation has the command of such means of bringing them to perfection; and if solid squares of infantry are ever to be penetrated by cavalry, it must be performed by cavalry armed with the lance.' But this will never be achieved by such a weapon as that at present in use. It must be effected by a lance of sufficient length to overcome the infantry bayonet, which, thus opposed, would no longer be formidable; and this lance must be put into the hands of our heavy cavalry, particularly the household troops, which, thus armed, would be able to contend on equal terms with the best infantry in the world, and would unquestionably be capable of penetrating its closest formation.

The British *Infantry* is composed of 3 regiments of guards,—viz., the 1st or grenadier regiment, the Coldstream regiment, and the 3d or Scots fusilier regiment, amounting together to 7600 rank and file; of 100 regiments of the line, consisting each of 1200 rank and file; of 1 rifle regiment (the 60th foot) and the rifle brigade, 2 battalions each; of 3 West India regiments; the field-train, 3 Newfoundland and 3 royal veteran companies, the Gold Coast corps, the Ceylon rifle regiment, the Malta fencibles, the Canadian rifle regiment, the St Helena regiment, and the Cape corps of mounted riflemen. The regiments of infantry of the line are commanded each by a lieutenant-colonel. With regard to the colonelcy of a regiment, it is in a great measure a sinecure, and is bestowed on old general officers; but a colonel is not debarred commanding a regiment in the field.

The ordinary staff of a battalion consists of 1 lieutenant-colonel, 2 majors, 10 captains, 12 lieutenants, 8 ensigns, 1 paymaster, 1 adjutant, 1 quartermaster, and 1 surgeon with 2 assistants—in all 39 officers. The petty staff is composed of a sergeant-major, a quartermaster-sergeant, a paymaster-sergeant, an armourer-sergeant, a schoolmaster-sergeant, 10 colour-sergeants, 30 sergeants, a drum-major, and 21 drummers—in all 106 men. In the regiments on field service the proportion is augmented.

The force serving in India previous to the mutiny in 1857, consisted of 2 regiments of light dragoons, and 21 battalions of infantry, or, including supernumeraries and others, 29,749 men and officers. At present (1858) the force numbers 92.739 men. Army.

The *Royal Artillery* forms only one corps, which is absurdly denominated a regiment, since, in the time of war, it is increased to more than 24,000 men. A general officer, with the title of adjutant-general, performs the functions of head of the artillery staff, but is in no way dependent upon the adjutant-general of the British forces. The office of the deputy-adjutant-general of artillery is at Woolwich, which may be considered the head-quarters of the ordnance. The royal artillery corps consists of the brigade of horse-artillery, and of the artillery serving on foot. The horse-artillery is subdivided into companies called troops. It is under the orders of 1 colonel-commandant, 2 colonels, *en second*, 4 lieutenant-colonels; while each troop is commanded by a captain of the first rank, a captain of the second, and 3 lieutenants. The foot artillery is divided into companies, under the orders of 12 colonels-commandant, 24 colonels, 36 lieutenant-colonels, 1 adjutant, 1 quartermaster, and a surgeon, with two assistants in time of war, and one during peace. In the year 1792 there were 4 battalions of foot artillery, consisting of 820 men each, with 1 battalion of invalids containing 483 men—making 3707 men in all. In 1814 there were 16,157 artillerymen, forming 11 battalions of 1459 men each. The rocket corps is attached to and forms part of the artillery; and the same holds true of the royal artificers, the field train, and the artillery drivers.[2]

In the war which preceded the peace of Amiens, and even in the early campaigns in Portugal, the *Engineer* department was in a very ineffective condition; particularly from the want of the necessary means of transport, and partly also from a deficiency both in the number and quality of military artificers. In order to remedy these inconveniences, the Duke of Wellington, in 1814, caused a brigade of engineers, consisting of a company of sappers and miners, with horses, cars, and drivers, to be attached to each division of the army, and to be regularly trained and exercised in field duties, as well as in those which might be required of them in sieges.

A captain and a certain number of subalterns were specially attached to each brigade, and were held responsible for the effective condition both of the men and the horses.

Thus the remainder of the engineers, free from any embarrassments relative to the *matériel* and *personnel* of that department of the service, were enabled to give their undivided attention to important military operations, and to contribute, in a most essential manner, towards the success of the succeeding campaigns. Five companies of sappers and miners also served with the pontoon train, which consisted of 80 pontoons, besides forges, waggons, &c., drawn by about 800 horses; the whole under the orders of a major of the brigade of engineers. After the peace great attention was paid both to the instruction and organization of this important branch of the service, which, since the war with Russia, and in many important civil duties connected with the survey of England and Scotland, and other public works. has been found on a very different footing, in point of efficiency, from that on which it stood during the greater part of the Peninsular campaigns. Experience taught important lessons, which have been suitably and effectually improved.

[1] The largest-sized cuirass worn by the life-guards weighs about 12 pounds. These cuirasses are as ugly as they are weighty, and give to the really fine men who are compelled to wear them an appearance of being *hump-backed*. The men do not regard them as defensive. They prefer such cover as the dexterous use of the sword can give them.

[2] Dupin, *Force Militaire de la Grande Bretagne*, I. v., c. 4, p. 196.

The portion of the British army presently serving in India amounts, as we have already seen, to about 92,739 men. It is paid by the East India Company, the officers receiving the same liberal allowances as they grant to those of their own service. Of late, the staff appointments of the Indian army, hitherto monopolized by the East India officers, have been, in a measure, thrown open to the royal officers, the only conditions of their eligibility being their acquaintance with one or more of the languages of the country.

In addition to the regular force, a militia is enrolled in England, numbering 80,000 men, divided into 85 regiments. The nucleus of an Irish and a Scotch militia is likewise preserved—the staff of no less than 54 regiments being constantly entertained; 15 of the regiments are Scotch, the residue Irish. Almost all of these regiments have been embodied, and some of them mobilized by act of parliament, which admits of their being sent to the Mediterranean. In the Channel Islands, also, are 10 regiments of militia infantry, and 3 of artillery; and in all the dockyards of England (Portsmouth, Devonport, Sheerness, Chatham, Woolwich, Deptford, Pembroke, &c.) the artificers and labourers are formed into brigades, properly commanded, equipped, and drilled. Thirty-five yeomanry corps, the honourable artillery company, which has its head-quarters in the precincts of the city of London, and the enrolled out-pensioners of Chelsea Hospital, complete the defensive force of the United Kingdom. The militia, always regarded as the nursery of the line, has contributed large numbers of disciplined men to the ranks of the regulars; and by way of encouragement to the militia officers to induce their men to volunteer, the government authorizes the commander-in-chief to confer line commissions on any militia subaltern who can bring 75 soldiers with him.

Down to the period of the late revolt there was an army belonging to the East India Company consisting of no fewer than 250,000 men, chiefly natives of the country, who were for the most part trained and clothed after the fashion of the British army. First enrolled in the days of Clive and Laurence, one hundred years ago, the sepoys have till lately proved "faithful to their salt," exhibiting considerable courage and endurance. In every corner of the continent of India—in Burmah, China, Afghanistan, the shores of Persia and Arabia, in Egypt, and even at Mauritius, in the presence of French disciplined troops—the sepoys distinguished themselves alike by their bravery, their fidelity, and discipline. And the result has been the entire subjugation of the country from Cape Comorin to the Himalaya chain—from Nepaul to the Arabian Sea. But it is due to the interests of truth to add, that the example of the British regiments has been of the greatest moment in the accomplishment of these mighty ends. Sir William Nott, who commanded a division of the army which invaded Afghanistan, and Sir David Ochterlony, who conquered the Nepaulese, had the most profound confidence in the sepoy. This confidence, which had become very common, has been destroyed by the late mutiny; and for the future the defence of our Indian empire must devolve on British troops.

The late army of the East India Company, before its disorganization, consisted of 5 brigades of horse artillery, or 17 European and 5 native troops; 18 battalions of foot artillery, or 24 European and 18 native companies; 22 regiments of regular native cavalry; 6 regiments of European infantry; 155 regiments of regular native infantry; 23 regiments of irregular native cavalry; 30 regiments of irregular native infantry; 5 contingent brigades of all arms, and a native legion. These troops were officered by Europeans holding commissions from the Crown and the East India Company, and expressly educated for the service. The staff, and all officers in the ordnance, commissariat, military account, survey, and pay departments, are commissioned officers in the service. The pay and Indian allowances are upon a liberal scale; and handsome pensions for life are granted to all classes after a stipulated period of service. Commissions in the East India service are not obtained by purchase, or through the gift of the British commander-in-chief. The patronage is vested entirely in the Court of Directors and the president of the Board of Commissioners for the affairs of India. Each member has a certain number of cadetships annually placed at his disposal, and these he must give away according to his discretion. Cadetships are not saleable. The law punishes with severity any trafficking in such commissions. Yet the practice of subscribing a sum of money in a regiment to induce a senior officer to retire is common, and receives the tacit sanction of the Court of Directors.

An admirable practice prevails among the officers of the Indian army of subscribing a small portion of their pay every month for the maintenance of two funds, one of which affords assistance to officers who may be obliged to proceed to England for the recovery of their health, and adds to the pension of retiring officers and their widows; while the other maintains destitute orphans.

The condition of the British soldier has been amazingly improved of late years, producing a decidedly favourable effect upon his *morale*, and creating a popularity for the service which it did not enjoy previous to 1830. The practice of employing the agency of fear as a stimulus to good conduct, has been superseded by the wholesome policy of encouraging merit by offering rewards for continued steadiness. The bounty on enlistment is no longer saddled with deductions for necessaries. Corporal punishment has been all but abolished—50 lashes now constituting the acmé of punishment. Good conduct, externally honoured by medals and badges, is also recompensed by a progressive increase to a soldier's daily pay; the sum of L.4000 is annually appropriated to annuities varying from L.10 to L.20, for which all non-commissioned officers of a certain amount of service are eligible; schools have been established, under the auspices of young men especially trained to the duty of teaching; libraries are formed in all the great barracks; medals have been freely granted for good service in the Peninsula, India, Egypt, the Crimea, &c.; provision is made for enabling a certain number of married soldiers to reside away from the barracks, and savings banks offer to the soldiery both the temptation to save and the means of securing their property. Great and important changes have of late years taken place in the arms and equipment of the soldiers; and long marches are consequently executed with greater facility. The construction of the knapsack, and the method of attaching it to the person, have been much improved, and even at this moment further amendments are discussed. The old musket—which seldom carried a ball above 180 yards, and was so irregular in its progress to the object aimed at, that the proportion of the enemy killed to the number of bullets propelled was 1 in 1000—has been superseded by firelocks of an improved construction, which will carry a ball 800 yards.

Formerly no display of remarkable valour in the field ensured to the private soldier a mark of royal approbation—promotion to the rank of non-commissioned officer was perhaps the only token he received that he had earned the approval of his commanding officer. By a recent warrant a new order has been created—the "Order of Valour," having for its decoration a bronze cross—the "Victoria Cross." Every soldier, of whatever rank, may possess this cross, with an annual stipend, if he has exhibited personal gallantry in the presence of the enemy. An Order of Merit—applicable to general deserving—is, however, still

a desideratum. Even in time of peace the heroism of the soldier is often called into play; and it is right that his devotion should be duly recognised. In cases of shipwreck, conflagrations, and civil outbreaks, when the discipline and patience of the soldier are severely taxed, a distinction like to that of the French Legion of Honour might fairly be awarded. It is bad policy to proclaim that the more active virtues developed in war are alone worthy of a decoration.

The character of the British army has been earned in battle and attested by victory. Wherever it has been even tolerably led it has conquered; nor is there any army in the world which has sustained so few serious reverses. The elements of which it is composed are such as, if fairly developed in action, must, on anything like equal terms, insure victory: for not only are the soldiers more robust, and possessed of greater physical power (or, as it is technically called, *bottom*), than those of any other nation, but they are also distinguished by an unflinching, indomitable courage, which may be safely reckoned upon at all times and in all circumstances; which it is often difficult to restrain, but never necessary to excite; and which always rises to a pitch of sublime elevation at the prospect of the charge and the close combat. They are the only troops in the world who look with indifference on naked points, and who are constantly impelled by a powerful instinct to close with their enemy; who maintain the distant battle with unyielding steadfastness, yet rejoice when the moment arrives that is to rest the issue of the conflict on the bayonet's point, and a struggle hand to hand with the enemy. Hence their fire is close, steady, and destructive; their charge, where it can be given, irresistible. "Les troupes Anglaises," says General Jomini, "se distinguent par leur bonne discipline et leur sang-froid; le soldat s'y enrôle pour la vie [this is a mistake; soldiers may enlist for ten years], ce qui est bien extraordinaire chez un peuple si jaloux de sa liberté, mais ce qui ne surprend pas moins, c'est qu'il est docile et soumis: ces qualités essentielles qui constituent une armée solide, sont peut-être préférables à une valeur brillante mais passagère. Les unes sont permanentes; l'autre, justifiant le proverbe Espagnol, dépend de tel jour et de telle circonstance. La résignation et la discipline unies au courage froid, ont des résultats invariables et sûrs; elles produisent l'ensemble sans lequel il n'est point de véritable force."[1] M. Dupin, in that part of his able work in which he treats of the military force of Great Britain, delivers an opinion somewhat similar to that expressed by Jomini, though shaded by certain qualifications and abatements.

But we need hardly quote foreign authors to demonstrate what the British soldier is when well commanded. The victories recently achieved in the Crimea, and the steady endurance of heart-rending sufferings during the long siege of Sevastopol, have proved to the world that he has in nothing changed, since, by his valour, perseverance, and discipline, he contributed, under the immortal Duke of Wellington, to give forty years of peace to the world. He is now engaged in the noble task of rolling back the tide of barbarism in conjunction with the French and Sardinians, and the best results may be anticipated from his gallantry and resolution.

(J. B—E. and J. H. S.)

ARNALDO, called from his birth-place DE BRESCIA, flourished in the first half of the twelfth century. After studying in France under Abélard, he returned to Italy and entered the church, the degeneracy and corruption of which at that time were a scandal to all true believers. Arnaldo set himself to denounce the profligacy and immorality of the great dignitaries of the church; and Brescia rose in rebellion against its bishop. The example was followed by other towns, and the contagion was only stopped by the banishment of Arnaldo. Retiring into France, the simple-minded monk was met and confronted by St Bernard, the famous abbot of Clairvaux, by whose means he was driven out of France. Returning to Rome, he found the people in rebellion against the Pope, put himself at their head, and for ten years kept the city in a state of chronic discontent with its spiritual head. This state of things lasted till Adrian IV. ascended the Papal throne. He excommunicated his own capital; and the Romans, utterly terrified, banished Arnaldo, who fled for safety into Campania. Peace, however, was not restored till his person was delivered up to the prefect of the city, who put him to death, burnt his bones, and threw the ashes into the Tiber in 1155.

ARNAUD DE MEYRVEILH, or MEREUIL, a poet of Provence, who wrote a book entitled *Las Recastenas de sa Contesse*, and a collection of poems and sonnets. Petrarch mentions him in his *Triumph of Love*. He is supposed to have died about the end of the twelfth century.

ARNAUD, *Daniel*, a still more celebrated troubadour than the preceding, flourished about the same period. He was born of a noble but poor family of Ribeirac in Perigord. When at the court of Richard I., an English jongleur challenged him to a trial of skill, and ten days were allotted for preparation. Arnaud, who was disinclined for the task, contrived, by listening at the door of his rival, to commit to memory the whole of the poem which the other had prepared and was learning to recite. When the day of trial was arrived, Arnaud requested permission to take the precedence, and gave forth the poem he had so cunningly appropriated. The jongleur was stupified with amazement, but Arnaud confessed the trick, the wager was withdrawn, and the king made rich presents to them both. Arnaud is extolled by Dante, Varchi, and Petrarch. Many of his amatory poems have been preserved, and some of them published by Raynouard. This name was likewise borne by several other troubadours.

ARNAUD DE RONSIL, *George*, son of an eminent surgeon at Paris, and some time professor of surgery in the College of St Côsme. On account of an accident that occurred while he was practising midwifery, he removed from Paris to London, where he acquired great repute by his operations, and his writings on surgical subjects. Before his time the treatment of *hernia* had been but imperfectly understood; and the surgeons of this country are indebted to the observations of Arnaud for many of those improvements which have since rendered their practice so successful in this branch of the art. He died in 1774.

ARNAUD, *Henri*, the celebrated pastor, leader, and historian of the Vaudois, was born in 1641 at La Torre in Piedmont, in which village also he was educated. How he spent the first years of his manhood is not known. It is said that he took service under William of Orange, afterwards William III. of England; but this, though likely, is not known for certain. He did not rise into notice till the time of the famous expedition of the Vaudois, who had been driven from their native valleys by the arbitrary cruelties of Victor Amadeus of Savoy. Driven into distant and widely-separated lands, the exiled Vaudois had been held together by the bonds of a common faith and a common patriotism, and had patiently and hopefully awaited their restoration. Twice they made the attempt, and twice they failed; and Arnaud, who seems to have had some hand in the second attempt, after leading off his followers, set out

[1] Jomini, *Guerres de la Révolution*, tom. ii., p. 252.

Arnaud.

for Holland, where he received advice and encouragement from the stadtholder, along with means for ensuring success to his next effort. When the English revolution of 1688 had been accomplished, Arnaud decided that the time for that next effort was at hand. Concentrating his followers in the great forest of the Pays de Vaud, he kept them for some time in concealment there. In September 1689 the Vaudois set foot in the valley of San Martino, which they reached after some bloody fighting with the French and Savoyard troops that opposed them. Their first care was to secure a strong position, which they luckily found, and fortified so well as to withstand the fiercest attacks of the French, repeatedly renewed during the course of the winter. The Vaudois boast, that during these engagements, while the foe was decimated, they lost not a single man. On the approach of summer Arnaud withdrew his troops from their stronghold, and led them to Angrona, where, just as they were on the point of abandoning themselves to despair, they learned that hostilities had broken out between France and Piedmont, and that their king, who had persecuted and expelled them, was now ready to receive them with open arms. Thus ended the "glorieuse rentrée des Vaudois dans leurs vallées"—effected, according to their own account, with a loss of only 30 men, while they make out that the joint losses of the French and Savoyards fell little short of 10,000 men. For a while the Vaudois were allowed to remain in peaceful possession of their ancient homes; but when the war of the Spanish Succession broke out, Arnaud and his followers took part in the combination against France, and rendered the allies much effectual service. But when that war came to a close, the ungrateful King of Piedmont once more joined the French monarch against his own subjects, and complied with the demands of that prince, that the Vaudois should be expelled from some of their valleys. The exiles, amounting in all to about 3000, found an asylum in Würtemberg. Their leader, who might have spent the remainder of his days in honour and comfort in England, choose rather to die, as he had lived, in the midst of his own people. He died at Schönberg in 1721, and every memorial that he left behind him was long cherished by his followers and their posterity.

Arnaud, *Marshal Le Roy de St*, was born in 1798. He was the son of an advocate who played an undistinguished part in the French Revolution, and who died when his son was only five years of age. After the usual training in the military schools, the young Le Roy entered the army, and volunteered in the cause of Greek independence. After some service in the East, he left the Greeks to their fate, and wandered, unattached, through Italy, Belgium, and England. At length an opening offered for his return home, when the old Bourbons were once more driven forth in 1830 to seek a foreign home. He obtained a commission, and in due time was sent to serve his country in Africa. His military character had there, for the first time, room to develop itself. His letters written at this time show him to have been a true soldier; faithful in the discharge; dashing forward, like his favourite Zouaves, at any obstacle that came in the way; daunted by no danger; and as reckless of his own life as of the lives of his men. When Louis Napoleon became President of the French Republic, St Arnaud began to pay court to him, and the President was far from unwilling to attach to his person a man like the African soldier, on whose loyalty he could rely. This confidence proved to be well founded when the great scheme of a restoration of the Empire rose to the mind of him who is now Napoleon III. The idea was no doubt due to the emperor himself; but the hand that gave it practical effect was St Arnaud's. The honours and rewards that were heaped upon him on the restoration of order, after the *coup d'état*, attest the value which his imperial master attached to his services. When the Russian war broke out St Arnaud was immediately fixed upon as the man of those then in France most competent to take the supreme command of the French army. Though his health was bad, and his constitution utterly broken up, he did not hesitate for a moment; but from the time when he assumed the chief power he executed with amazing energy and industry the numerous and responsible duties which it entailed upon him. His letters written at this date show that he regarded himself as the master and genius of the war; and there is no doubt that his death, which happened September 29, 1854, a few days after the victory of the Alma, was felt as a very serious blow both by France and England.

Arnaud

Arnauld.

St Arnaud really was what he was always proud of being thought—a Zouave. To gain a point there was no sacrifice too great for him to make. Restless, eager, thirsting for blood and battle-fields, he dashed at his point like a tiger on its prey. He was not capable of planning a great campaign; but, in the present dearth of military genius, he takes his place in the foremost rank of all the soldiers who have shared in the Russian war. Along with some of the best qualities of the soldier, St Arnaud possessed also some of the worst. He was, if not positively cruel, at least reckless of human life and suffering. His passions were strong, and, as they were perfectly uncontrolled, they often hurried him away into crimes and excesses, which in a less brave, less loyal, or less devoted man, might fail to obtain that pardon which his latterly heroic career and noble end ensure for St Arnaud. His letters, in 2 vols., Paris, 1855, are among the most interesting specimens of epistolary literature that have appeared in our age.

Arnaud, or Arnoldus, de Villa Nova, a famous physician and alchemist, who lived about the end of the thirteenth and beginning of the fourteenth century. He studied at Paris and Montpelier, and improved himself by visiting the schools of Italy and Spain. He was well acquainted with languages, particularly with the Greek, Hebrew, and Arabic. His desire after the acquisition of knowledge was ardent, but it carried him too far in his researches. He put unlimited faith in astrology, and published a prediction that the consummation of the world would take place in the year 1335. He practised physic at Paris for some time; but having advanced some new doctrines, he drew upon himself the resentment of the university; and his friends, fearing he might be arrested, persuaded him to retire from that city. He went to Sicily, where he was received by King Frederic of Aragon with the greatest marks of kindness and esteem. Some time afterwards this prince sent him to France to attend Pope Clement in an illness; and in this voyage he perished by shipwreck on the coast of Genoa about the year 1313.

Arnaud has been called the discoverer of the sulphuric, the muriatic, and the nitric acids, as well as of the essential oil of turpentine; and is said to have been the first to give regular scientific details of the process of distillation; but Dr Hoefer (*Histoire de la Chimie*, tom. i., p. 385) has shown that all these discoveries were made long before the time of Arnaud. His works, with a life prefixed, were first printed at Lyons in 1504, in one volume folio, and again in 1520 with the notes of Nicholas Tolerus; and at Basil in 1515 and 1585.

ARNAULD, Antoine, one of the greatest of French theologians and philosophers, was the twentieth child of Antoine Arnauld, the most famous advocate of his time, who in 1594 distinguished himself in the Parliament of Paris by pleading the cause of the university against the Jesuits. In the son that formidable society found during his active and polemical life a still more powerful and unwearied adversary. The whole family of the Arnaulds was devoted to the cause of Jansenism, and its female members, especially the celebrated "mère Angélique" are so identified with the history of the

abbey of Port Royal, that some notice of them will necessarily fall under the account of that remarkable institution. The elder Arnauld was himself a liberal supporter of Port Royal, and his wife, his six daughters, and five of his granddaughters, became nuns there. Three out of four sons who survived him became distinguished men.

Of these the youngest, Antoine, justly called by the Port Royalists, *le Grand*, was born at Paris, Feb. 6. 1612. After studying at the colleges of Calvi and Lisieux, he turned his attention to the study of law; but the influence of the Abbé St Cyran, director of Port Royal, and the advice of his mother, led him to choose the ecclesiastical profession. The same influence directed him to study the works of St Augustine, and he soon gave evidence of having entered into the spirit of that Father's theology. In 1641 he took his degree as Doctor of the Sorbonne, and after being twice rejected on formal grounds, he was in 1643 admitted a member of the *Society of the Sorbonne.*

Before this time his mind had undergone a deep change. The instructions of St Cyran, and the dying words of his mother, had impressed him with religious convictions of a more penetrative and influential kind than he had experienced hitherto, and from this time he devoted himself with all the ardour of his soul to the defence and propagation of what he believed to be the truth. In August 1643 he published his famous treatise *de la Frequente Communion*, expressly directed against the loose and scandalous doctrines of the Jesuits, who held on this subject that the beneficial reception of the sacraments required no preparation, and that open sin in the communicant is no bar to the benefits of the Eucharist. The severer doctrine of Arnauld soon drew down upon him the vengeance of the Jesuits; and the support of the parliament, and the approbation of a large body of prelates and doctors of the Sorbonne, were not sufficient to save him from their implacable hostility. He was obliged to seek safety in flight, and though his subsequent life had intervals of comparative security and repose, it may be said that from this time till his death he lived a harassed and persecuted fugitive.

His work on Frequent Communion is remarkable not merely on account of its important consequences to the author, but as the first theological work in France written in a pure and grammatical style, and entirely free from the barbarous subtleties of the preceding centuries.

In the year 1656 the college of the Sorbonne showed its complete subjection to the influence of the Jesuits, by effacing the name of Arnauld from the list of its doctors, and passing an act that no one should in future be admitted to the degree who did not sign the censure passed upon his heresies. The accusation against him was founded on two propositions in his *Letter on Absolution*—1*st*, that the five heretical propositions attributed to Jansenius were not contained in the *Augustinus*, and 2*d*, that the Fathers of the Church exhibit to us in the person of St Peter a saint who was deficient in saving grace.

From this time till 1668 Arnauld lived in concealment, incessantly occupied in writing against the Jesuits, and animating by his counsel and example the oppressed but powerful party who recognized in him their head and oracle. About the end of this period he composed the most enduringly valuable of his numerous works, the *Port Royal Grammar; New Elements of Geometry;* and the *Port Royal Logic, or Art of Thinking;* of all which it is sufficient to say that their value as important contributions to their several departments of science has not yet been superseded by the labours of subsequent writers.

In 1668 the so-called *Peace of the Church*, by Clement IX., recalled Arnauld from his exile; and on this occasion he was presented to the king and the papal nuncio, who received him with the outward forms of flattering distinction.

To convince the world of the falsehood of the Jesuitical accusation that the Jansenists were the abettors of Calvinism, Arnauld now devoted his controversial powers to the defence of the Roman Catholic faith against the Protestants. The great work composed chiefly by Nicole, but published under the name of Arnauld, *Perpétuité de la Foi de l'Eglise sur l'Eucharistie*, a voluminous and elaborate defence of transubstantiation, is the most important of these proofs of Jansenist orthodoxy.

His inextinguishable controversial ardour, and the persevering hostility of his enemies, once more drove Arnauld into exile. In 1679 he received a formal order from Louis XIV. to provide for his safety, and in the course of a few days he was again an exile in the Flemish city of Mons. From this time onward he had little rest till his death. Wandering from one city to another he kept up unweariedly the warfare in which he found his congenial element. Of the unquenchable activity of his spirit, a characteristic illustration is his well-known reply to Nicole, who urged him at one time to think now of desisting from his harassing labours and indulging in some repose. "Rest!" said the untired warrior; "shall we not rest in Eternity!" At Brussels in 1694 his manifold labours came to an end, in the 82d year of his age. His body was buried where he died; his heart, at his own request, was carried to Port Royal, of which he had been in life the most redoubtable defender.

The life-long warfare of Arnauld was not confined alone to the defence of Jansenism. His love of truth and of discussion found subjects for his polemical activity in the works of his most valued and intimate friends. Descartes and Malebranche, Pascal and Domat, Nicole and Gilbert of Choiseul, and his protector Pope Innocent XI., all in various ways gave scope to his unconquerable controversial zeal.

"In Arnauld," says Mr Baynes, the able translator of the Port Royal Logic, "are found singularly united many of the best virtues of his time. Love of truth and freedom, fearless intrepidity, stainless honour, and inflexible justice, are ever found in his writings. Bowing to the authority of the church, yet confronting the thunders of the Vatican—rejecting the old philosophy, yet reproducing the truth which it contained—accepting the new, yet fearlessly discussing its dogmas with Descartes—he vindicated incessantly the claims of reason and faith, with an earnestness and impartiality which the love of truth alone could inspire. There is, indeed, scarcely any sight, even in that age of great men and great controversies, more inspiring than that of Arnauld doing battle, single-handed, with all that was mightiest, both in church and state—replying to every attack with an energy which was never wearied, a fertility of resource which was never exhausted, and a freshness of thought and power of argument rarely equalled, and perhaps never excelled."—*Introduction to Port Royal Logic.* (Edin. 1850.)

The works of Arnauld compose, in the edition of 1783, 48 vols. in 4to. This immense collection comprehends treatises on theology, philosophy, literature, science, and politics, all giving proof of that wonderful power which, in the midst of labours so constant and multifarious, never showed any symptom of decline. Arnauld also had a considerable share in the famous translation of the Bible by his nephew De Saci.

ARNAY-LE-DUC, a town of France, in the department of Cote d'Or, which carries on a pretty good trade. It is seated on the Auxois, in a valley near the river Aroux. Pop. in 1846, 2331. Long. 4. 26. E. Lat. 47. 7. N.

ARNDT, John, a famous Protestant divine of Germany, born at Ballenstadt, in the duchy of Anhalt, in the year 1555. He died in 1621. His *Treatise on True Christianity* has been translated into several languages.

ARNE, Thomas Augustine, doctor of music, was born

in 1710, in King Street, Covent Garden, where his father was an upholsterer. He served three years with an attorney; but his strong propensity for music prevailed over the law, and he finally devoted himself to that science, in which he soon became so eminent as to receive the degree of doctor from the University of Oxford in 1759. He was an extensive composer, and adapted upwards of thirty musical pieces for the stage. They are characterized by a natural ease and elegance, a flow of melody, and a fulness and variety without affected or extraneous modulation. His most celebrated works are *Artaxerxes*, paraphrased from Metastasio; the *Masque of Comus;* the *Opera of Operas*, a burletta; the *Guardian Outwitted;* and the *Rose;* some of which have taken a permanent hold of the stage. Dr Arne died March 5. 1778.

ARNHEIM, a fortified town of Holland, capital of the province of Guelderland, 50 miles south-east of Amsterdam, and 35 miles E.S.E. of Utrecht, with both of which it is connected by the Dutch-Rhenish Railway. This has been selected as the point of communication between the various railways of Germany and Holland. It stands on the right bank of the Rhine, about three miles below the point where the Yssel branches off from it, and which is here crossed by a bridge of boats. It is well built, and its neighbourhood abounds with beautiful villas, parks, and gardens. It has a grammar school and several learned societies, courts of assize and commerce, a governor's palace, and extensive new barracks. The church of St Eusebius, in which the old dukes and counts of Guelderland lie buried, contains many sepulchral monuments of interest. It has a good port on the river, an active general trade, and manufactures of woollen, cotton, paper, tobacco, &c. Pop. in 1850, 18,671. Lat. 51. 58. 46. N. Long. 5. 54. 43. E.

ARNICA, a botanical genus of the natural order of Compositæ. The English name of *A. montana* is Leopard's bane. It is a powerful narcotico-acrid, and has been used in medicine, especially in chronic rheumatism, and as a diuretic in atonic dropsy.

ARNISÆUS, Henningus, a philosopher and physician of great reputation about the beginning of the seventeenth century. He was born at Halberstadt in Germany, and was professor of physic in the university of Helmstadt. His political works are much esteemed. The most remarkable of them is his book *De Autoritate Principum in Populum semper Inviolabili*, printed at Frankfort in 1612. He wrote also upon the same doctrine his three books, *De Jure Majestatis*, printed at the same place in 1610; and his *Reflectiones Politicæ*, printed at Frankfort in 1615. He went to Denmark by invitation, and was made counsellor and physician to the king. He travelled into France and England, and died at Fredricksborg in 1636. Besides the pieces already mentioned, he wrote several philosophical, medicinal, and poetical treatises.

ARNO (ancient Arnus), the celebrated river of Florence, which rises in Monte Falterona, in the Apennines, and descends into the valley of Casentino, in Upper Tuscany. It passes the town of Bibbiena into the plain of Arezzo, where it receives the Chiana as a tributary, and enters the narrow valley of Laterina. Thence it issues through the rocky defile Dell' Inferno, pours into the lovely Val D'Arno, sweeps beneath the woods of Vallombrosa, and after receiving the Sieve, enters the plain of Florence, and proudly flows through the celebrated capital of Tuscany. Ten miles below Florence, it is confined in an artificial channel, formed by the ancient Etruscans, for the purpose of draining the plain. It receives several tributaries, and enters the plain of Pisa, which it traverses; and after a further course of eight miles, falls into the Tuscan sea. Its whole winding course is about 140 miles. At Florence it is 400 feet wide, but is fordable in summer. It is liable to sudden floods, and then is impetuous, carrying down with it immense quantities of earth and stones, by which its bed is elevated; in many places requiring frequent embankment. On the banks of the upper Arno, are vast accumulations of fossil bones of the elephant, rhinoceros, hippopotamus, and bear, especially between Arezzo and Florence.

ARNOBIUS, one of the earliest apologists of Christianity in the west, was a teacher of rhetoric at Sicca (now Keff), in Numidia, towards the end of the third century. Becoming dissatisfied with his ancestral faith, and harassed with doubts, which pursued him even in his dreams, he became desirous of embracing Christianity, and for this purpose applied to the bishops for admission into the church; but his former violent hostility to the faith led them to distrust him, and, before they would consent, they insisted on some proofs of his sincerity. In compliance with this demand, he wrote against the Gentiles, refuting the absurdities of their religion, and ridiculing their false gods. In this treatise he has employed all the flowers of rhetoric, and displayed great learning; but it is defective in arrangement, and manifests but an imperfect knowledge of the Christian faith. His work bears the title *Adversus Gentes*, and there are several editions of it. The best is that of *Orelli*, Lips. 1816. 2 vols. 8vo. He wrote also a piece entitled *De Rhetoricæ Institutione*, which is not extant.

ARNOLD of Brescia (*Arnaldus*, or *Arnulphus Brixiensis*), distinguished himself in the twelfth century, as the founder of a sect which opposed the wealth and corruption of the Roman clergy. He went into France, where he studied under the celebrated Abelard. Upon his return to Italy he put on the habit of a monk, and opened his invectives in the streets of Brescia. He pointed his declamation against the bishops, the clergy, the monks, and finally against the Roman pontiff himself; to the laity only was he indulgent. In 1139 he was cited to appear before a grand council at Rome. His accusers were the bishop of Brescia, and many others whom he had ridiculed and insulted. Nor from his judges could he look for much indulgence. He was found guilty, and sentenced to perpetual silence. Upon this he left Italy, crossed the Alps, and found a refuge in Zurich. After the death of Pope Innocent II. he returned to Italy, headed an unsuccessful revolt in Rome, and was ultimately condemned to death and crucified in 1155. His name is deserving of being remembered for the boldness of his attempt to lower the power of the pope and his clergy, in an age when the papacy existed in all the plenitude of its influence. His followers were known as *Arnoldists*.

Arnold, *Benedict*, a noted officer in the war of American Independence. He was born in Connecticut in 1740; engaged with zeal in the cause of his countrymen, and rose to be a general of brigade. He was appointed, after a wound in the leg, to the command of Philadelphia, where he committed such acts of rapacity, that he was tried by a court-martial in 1779, and reprimanded. On this he resigned his commission; and appears from that time to have entered on the dishonourable scheme, for which now he is chiefly remembered, that of betraying his country to the British. These negotiations led to the death of the gallant and unfortunate Major André, while the guilty Arnold escaped to the British headquarters. He retained in the British the rank he had held in the American army, and was employed in Virginia and Connecticut; in both of which he committed great devastation, especially in his native province, where he butchered the garrison of Fort Turnbull, and burnt New London. He was taken by the French while in our service in the West Indies, but made his escape. On the peace, he retired to Britain, where he died in 1801. His duel with Lord Lauderdale, in 1792, on account of some vituperative expressions used by his Lordship at a public meeting, is well know

Arnold.

Arnold Strutthan von Winckelried, one of the heroes of Swiss independence. When Leopold Duke of Austria, in conjunction with the nobles of Switzerland, attempted in 1386 to destroy the liberty of the people, the whole force which the Swiss had to oppose a regular army of 4000 soldiers amounted but to 1400 men, undisciplined and badly armed. They met under the walls of Sempach in Lucerne, and the Swiss were about to retreat, when the fate of the day was decided by Arnold, who rushed forward, and seizing in his arms the spears pointed against his friends, received them in his bosom. The enemy was routed; Leopold and most of his noble followers being slain; and the independence of Switzerland was secured. See Switzerland.

Arnold, *Samuel*, doctor of music, was born in 1740, and was received into the royal chapel at an early age, where he was successively the pupil of Mr B. Gates and Dr Nares. In 1764, he became the composer for the orchestra of Covent Garden Theatre; and two years afterwards also had the same office at the Haymarket. He is the author of 40 musical dramas, among which are *The Maid of the Mill*, *Inkle and Yarico*, *The Son-in-law*, *The Battle of Hexham*, *The Surrender of Calais*, *The Babes in the Wood*, *The Mountaineers*, with the oratorios of *Saul*, *Abimelech*, *The Prodigal Son*, and *The Resurrection*. In 1783, he was appointed organist and composer to the king; and in 1789, conductor of the Academy of Ancient Music. We owe to him the publication of the works of Handel and Boyce. He died in 1802, and was interred in Westminster Abbey.

Arnold, *Thomas*, a clergyman of the Church of England, was born at West Cowes, in the Isle of Wight, on the 13th of June 1795. He was the son of William and Martha Arnold, the former of whom occupied the situation of collector of customs at Cowes. Deprived at an early age of his father, who died suddenly of spasm in the heart in 1801, his initiatory education was confided by his mother to her sister, Miss Delafield, who with affectionate fidelity discharged to him the office with which she had been intrusted. From her tuition he passed to that of Dr Griffiths, at Warminster, in Wiltshire, in 1803; and in 1807 he was removed to Winchester, where he remained until 1811, having entered as a commoner, and afterwards become a scholar of the college. In after life he retained a lively feeling of interest in Winchester School, and remembered with admiration and profit the regulative tact of Dr Goddard, and the preceptorial ability of Dr Gabell, who were successively head-masters during his stay there.

As a schoolboy he was not particularly distinguished by any of those attainments which usually determine the honours of the class. Beyond a very retentive memory, a love for solitary reading, and a certain precocity in the writing of English verse, he afforded but few indications of any superior power of intellect or any decided impulse towards literary pursuits. He was shy and somewhat stiff in his manners, inclined to prefer the society of persons more advanced in life to that of his schoolmates, and somewhat inordinately resolute in holding by any opinion he had formed or any purpose he had adopted. At the same time it is easy to trace in the favourite pursuits of his boyhood, and in the development of his youthful character, many of the most characteristic features of the future man. He was strong and fast in the friendships he formed amongst his fellows. He was already a careful and curious observer of character, and instinctively cleaved to the noble and the gentle, the vigorous and the pure, in whomsoever found. He was almost from infancy devotedly attached to the study of history and geography, as well as to ballad poetry. Already, however, he had begun to allot separate places in his mind to the romantic and to the real in narration; and whilst he relished both, he steadily refused to accept the one for the other. No boy had a heartier enjoyment of the myth or the ballad; but even as a boy he had begun to look with distrust upon much of the ancient history as, "if not totally false, at least scandalously exaggerated." In the stillness of these studies, and in the stream of schoolboy society, there can be little doubt that (according to "a true saying" of the great German poet) the talents and the character of the future historian of Rome and head master of Rugby, began to receive their peculiar mould.[1]

From Winchester he removed to Oxford in 1811, where he became a scholar at Corpus Christi College; in 1815 he was elected Fellow of Oriel College; and there he continued to reside till 1819. This interval was diligently devoted to the pursuit of classical and historical studies, to preparing himself for ordination, and to searching investigations, under the stimulus of continual discussion with a band of talented and congenial associates, of some of the profoundest questions in theology, ecclesiastical polity, and social philosophy. The authors he most carefully studied at this period were Thucydides and Aristotle, and for their writings he formed an attachment which remained to the close of his life, and exerted a powerful influence upon his mode of thought and opinions, as well as upon his literary occupations in subsequent years. Herodotus also came in for a considerable share of his regard, but more, apparently, as a book of recreation than one for work. In prosecuting his historical studies he adopted the plan which he afterwards recommended to his students in his lectures at Oxford, that of selecting some one period of which he made himself thoroughly master, and with reference to which he surveyed the events and persons that came under his notice either in the course of his more general reading, or as an observer of what was going on around him. In theology, his mind, accustomed freely and fearlessly to investigate whatever came before it, and swayed by an almost scrupulous dread of aught that might appear to savour of insincerity, was doomed to long and anxious hesitation upon several points of fundamental importance before arriving at a serene and settled acceptance of the great verities of Christianity. Once satisfied, however, of these, his faith remained clear and firm; and having received his religion, not by tradition from men, but as the result of an earnest, penetrating, and honest examination of the evidence on which it rests, he not only held it with a steadfast grasp, but realized it and felt it as a living and guiding power. From this time forward his life became supremely that of a *religious* man. He had not only embraced orthodox sentiments, and seen his way to an honest conformity with the ecclesiastical arrangements and worship of the church to which he belonged, but he had experienced within his own soul the renovating and transforming energy of divine truth. Christianity was no longer a something which he had taken upon him; it was a life, a nature within him. Long exercised with doubts and difficulties as to the person and claims of Jesus Christ, he had at length reached to such an intense and all-subduing conviction on these points that a continual consciousness of love and adoration, of joy and confidence towards the Redeemer, seems to have occupied his bosom. To the name of Christ he was prepared to "surrender his whole soul," and to render before it "obedience, reverence without measure, intense humility, most unreserved adoration."[2] It was his joy and consolation when lost amid the mysteries which sur-

[1] "Es bildet ein Talent sich in der stille;
Sich ein charakter in dem strom der Welt."—*Goethe.*

[2] Sermons, vol. iv. p. 210.

round the being and government of the Infinite, to remember that, "in that unknown world in which our thoughts become instantly lost, still there is one object on which our thoughts and imaginations may fasten, no less than our affections; that, amidst the light, dark from excess of brilliance, which surrounds the throne of God, we may discern the gracious form of the Son of Man."[1] This vivid realization of Christ as the centre and source of his religion, communicated peculiar animation as well as a single-hearted simplicity to his piety. To be like Christ—to please Christ—to have communion with Christ—to enjoy blessing from Christ:—these became the leading ideas and the ever-present impulses of his religion. Hence not only had all religious doubt and perplexity disappeared, but a new impulse was communicated to his whole spiritual life; his battle with evil in all its forms became more intense; his activity became more subject to a high sense of duty and an earnest desire to acquit himself well as a good soldier of Jesus Christ; and amidst the throng and bustle of this world he ever maintained a conscious sense of the spiritual state which had been revealed to him, and to which he felt himself continually drawn by his love to his Redeemer. He did not often talk about religion; he had no inclination to gossip about his experience, or dwell upon the frames and feelings through which he passed; he had not much of the accredited phraseology of piety even when he discoursed on spiritual topics. But no man could observe him for any length of time without feeling persuaded that more than most men he was directed by religious principle and feeling in all his conduct. The fountain of his piety was in his heart's core; and its streams mingled easily with all the issues of his life. As his biographer has beautifully remarked, "his natural faculties were not unclothed but clothed upon; they were at once coloured by, and gave a colour to, the belief which they received."[2]

He left Oxford in 1819 and settled at Laleham near Staines, where he was occupied chiefly in superintending the studies of seven or eight young men who were preparing for the university. His spare time was devoted to the prosecution of studies in philology and history, more particularly to the study of Thucydides, and of the new light which had been cast upon Roman history and upon historical method in general by the researches of Niebuhr. He was also occasionally engaged in preaching, and it was whilst here that he published the first volume of his sermons. Shortly after he settled at Laleham he entered into the marriage relation with Mary youngest daughter of the Rev. John Penrose, rector of Fledborough, Nottinghamshire.

Under the plastic influences of domestic life, and amid the congenial occupations which divided his time at Laleham, his character was gradually maturing, his intellectual powers were becoming more fully developed, his opinions on social and ecclesiastical questions were acquiring consolidation and precision, and he was laying up a stock of experience and forming plans which demanded a much wider sphere for their operation than such a post as that which he now occupied could present. It was not long before such a sphere opened before him. After nine years spent at Laleham, he was induced to offer himself as a candidate for the head-mastership of Rugby, which had become vacant; and though he entered somewhat late upon the contest, and though none of the electors were personally known to him, he was nevertheless successful. He was elected in December 1827; in June 1828 he received priest's orders; in April and November of the same year he took his degree of B.D. and D.D.; and in August entered on his new office.

In one of the testimonials which accompanied his application to the trustees of Rugby, the writer stated it as his conviction, that "if Mr Arnold were elected, he would change the face of education all through the public schools of England." Nobly was this somewhat hazardous pledge redeemed by him in whose name it had been given. Arnold's head-mastership at Rugby constituted a new era in the history of public education in England. By his skill, devotedness, and high moral earnestness, even more than by his scholarship or his direct tutorial influence, he completely "changed the face of education" at that great institution, and set an example which has acted upon all the educational institutions of the empire. Under his superintendence the school became not merely a place where a certain amount of classical or general learning was to be obtained, but a sphere of intellectual, moral, and religious discipline, where healthy characters were formed, and men were trained for the duties, and struggles, and responsibilities of life.

Rugby was privileged to enjoy his superintendence for nearly fourteen years. During this period his energies were chiefly devoted to the business of the school; but he found time also for much literary work, as well as for an extensive correspondence. Five volumes of sermons, an edition of Thucydides, with English notes and dissertations, a History of Rome in three vols. 8vo, besides numerous articles in reviews, journals, newspapers, and encyclopædias, are extant to attest the untiring activity of his mind, and his patient diligence during this period. His interest also in public matters was incessant, especially in such as bore upon the social welfare and moral improvement of the masses. Ecclesiastical questions occupied at all times a large share of his regards; he was earnest for church reform, and continually disposed to take a despairing view of the prospects of the hierarchy. From the outset he had watched with intense interest the progress of those opinions and tendencies at Oxford which have of late years excited so much public attention, and have issued in results which Arnold was among the first to predict.

In 1841 Dr Arnold received from Lord Melbourne, then prime minister, the offer of the chair of Modern History at Oxford, an offer which he accepted with peculiar satisfaction. The situation was one which connected him once more with the university where his own earlier studies had been conducted, and for which he ever retained the liveliest affection; its duties were not onerous, and they fell in with the course of his favourite pursuits; and it afforded him a provision against the time when he should be compelled to retire from the responsibilities of such an institution as Rugby, and seek that lettered ease to which, amidst all the distractions of his active life, he was continually looking forward as the ultimatum of his earthly ambition. On the duties of this new office he entered on 2d December 1841, by delivering his inaugural lecture, amidst circumstances which he felt to be peculiarly gratifying and flattering. Seven other lectures were delivered during the first three weeks of the Lent term of 1842; the whole have been published since his death.

A few months after the delivery of his lectures, Arnold was suddenly removed from his earthly duties and anticipated enjoyments by an attack of angina pectoris. The Midsummer vacation had arrived, and he was preparing to set out with his family to Fox How, a favourite retreat, where he had purchased some property and built a house, in Westmoreland. After a busy day spent in various duties, he retired to rest apparently in perfect health. Between five and six next morning he awoke in severe pain. All attempts to arrest the fatal malady proved fruitless. He bore with heroic fortitude and Christian resignation his sufferings,

[1] Sermons, vol. iii. p. 90.

[2] Life by Stanley, vol. i. p. 31.

until eight o'clock, when he expired. The day on which he died was Sunday, the 12th of June 1842. "What that Sunday was in Rugby," says his biographer, "it is hard fully to represent: the incredulity—the bewilderment—the agitating inquiries for every detail—the blank, more awful than sorrow, that prevailed through the vacant services of that long and dreary day—the feeling as if the very place had passed away with him who had so emphatically been in every sense its head—the sympathy which hardly dared to contemplate, and which yet could not but fix the thoughts and looks of all on the desolate house where the fatherless family were gathered round the chamber of death." His remains were interred on the following Friday in the chancel of Rugby chapel, immediately under the communion-table.

We have no space left to attempt a delineation of the separate features of Arnold's character. We can only remark in general, that the great peculiarity and charm of his nature seemed to lie in the regal supremacy of the moral and the spiritual element over his whole being and powers. His intellectual faculties were not such as to surpass those of many who were his contemporaries; in scholarship he occupied a subordinate place to several who filled situations like his; and he had not much of what is usually called tact in his dealings either with the juvenile or the adult mind. What gave him his power, and secured for him so deeply the respect and veneration of his pupils and acquaintances, was the intensely religious character of his whole life. He seemed ever to act from a severe and lofty estimate of duty. To be just, honest, and truthful, he ever held to be the first aim of his being. Amid the trials and the duties of life alike, he "endured, as seeing Him who is invisible." Like Milton, who had also been a schoolmaster, his principle seems to have been—"Were it the meanest under-service, if God, by his secretary Conscience, enjoin it, it were sad for me if I should draw back." With all this, there was intense sympathy with his fellows, the tenderest domestic affections, the most generous friendship, the most expansive benevolence. But to understand aright his claims upon our respect and homage, the history of his life must be read at large. As has been truly observed by one who seems to have known him well—"His Thucydides, his history, his sermons, his miscellaneous writings, are all proofs of his ability and goodness. Yet the story of his life is worth them all."—*Edin. Rev.*, vol. lxxxi., p. 234. His life has been most ably written by the Rev. A. P. Stanley, M.A., in two volumes, 8vo. Lond. 1845. (W. L. A.)

ARNOLDUS, Gothofredus, pastor and inspector of the churches of Perleberg, and historiographer to the king of Prussia, was born at Annaburg, in the mountains of Misnia, in 1666. He was a zealous defender of the Pietist sect, and composed a great number of religious works, particularly an *Ecclesiastical History*, which exposed him to the resentment of the divines, and another giving an account of the doctrines and manners from the first ages, in which he frequently animadverts upon Cave's *Primitive Christianity.* He died in 1714.

ARNSTADT, a town in the principality of Swartzburg, Sonderhausen, on the river Gera, 14 miles south-east of Gotha. It has a castle, four churches, a workhouse, an orphan asylum, and two hospitals; with an active corn and timber trade; and manufactures of woollen, linen, cotton, paper, leather, &c. Pop. 6000.

ARNULPH, or Ernulph, bishop of Rochester in the reign of Henry I. He was born in France, where he lived some time a monk in the monastery of St Lucien de Beauvais. The irregular lives of the monks determined him to quit their society, and on the invitation of his former prior Lanfranc, archbishop of Canterbury, he removed to England, and took up his abode in the monastery of Canterbury. After the death of Lanfranc, Arnulph was made prior of the monastery of Canterbury, and afterwards abbot of Peterborough. In 1115 he was consecrated bishop of Rochester, which see he held nine years, and died in March 1124, aged 84. Arnulph wrote in Latin an account of the foundation, endowment, charters, laws, &c., of the church of Rochester: it is known by the title of *Textus Roffensis,* and is preserved in the archives of the cathedral of Rochester. It has been printed in Thorpe's *Registrum Roffense.*

ARNWAY, John, D.D., a clergyman distinguished for his piety and exemplary charity, was descended of a good family in Shropshire, and inherited a considerable estate. He zealously espoused the cause of King Charles I.; and after suffering imprisonment and the sequestration of his estate during the civil wars, he retired, on the ruin of Charles's cause, to the Hague. There he published, in 1650, a tract entitled *Tablet, or Moderation of Charles I., Martyr, with an Alarum to the Subjects of England.* From the Hague he went to Virginia, where he died in 1653.

AROER, the name of four towns mentioned in Scripture. (1.) A town on the north side of the river Arnon, the ruins of which were found by Burckhardt, under the name of Araayr. (2.) One of the towns built, or probably rebuilt, by the tribe of Gad. Its ruins are supposed to be those of Ayra, noticed by Burckhardt. This Ayra, about seven miles south-west from Szalt, is probably the same with the *Array*-el-Emir, visited by Legh, on his way from Heshbon to Szalt, and which in Berghaus's celebrated map of Palestine is placed nine English miles W.N.W. of Rabbah. (3.) A city in the tribe of Judah. (4.) A city in the south of Judah, to which David sent presents after recovering the spoil of Ziklag. Dr Robinson supposes that he found traces of this town in the valley of Ararah, about 20 geographical miles south by west from Hebron.

AROIDEÆ, a natural order of plants, the species of which are acrid, and many of them very poisonous, as the genus *Arum;* but the poisonous principle is dissipated by heat. Some of the order give out much heat when flowering, and some at that time have an offensive smell.

ARONA, a town of the Sardinian States, province of Novara, near the southern extremity of Lake Maggiore. Lat. 45. 45. 57. N. Long. 8. 33. 6. E. It is well built; and has a strong castle, a gymnasium, several churches, a hospital, a port and dockyard on the lake, and a considerable trade. Pop. 4000. In 1697 the people of Milan erected, on an eminence in this vicinity, a colossal statue in honour of San Carlo Borromeo, a man distinguished for his piety and benevolence, who was born here in 1538, and afterwards became cardinal and archbishop of Milan, where he died in 1584. The statue stands on a granite pedestal 46 feet high, and is itself 66 feet in height. In the interior of the statue are stairs leading up to its head, which is so large that four persons can sit in it at a table.

AROO, or Arru, a group of islands in the Eastern Archipelago, lying about 80 miles south-west of Papua, between Lat. 5. 20. and 6. 55. S.; and Long 134. 10. and 134. 45. E. These islands produce pearl, mother-of-pearl, tortoiseshell, birds of paradise, edible birds'-nests, trepang, &c. The inhabitants are a mixture of the Malay and Australasian negro races. The largest of these islands is 70 miles long and 20 broad.

AROPH, a contraction of *aroma philosophorum,* a name given to saffron.

Aroph Paracelsi, a name given to a kind of chemical flowers, probably of the same nature with the Ens Veneris, elegantly prepared by sublimation from equal quantities of lapis hæmatites and sal ammoniac.

ARPINAS, or Arpino, Giuseppe Cesare, a famous painter, born in the year 1560, at the castle of Arpinas, in the kingdom of Naples. He lived in great intimacy with Pope Clement VIII. who conferred upon him the honour

of knighthood, and many other marks of friendship. His paintings of Roman history are the most esteemed of all his works. He died at Rome in 1640.

ARPINO (the ancient *Arpinum*), a town of Naples, in the province of Terra di Lavoro, pleasantly situated on an eminence 6 miles south of Sora. It has a considerable trade, and manufactures woollen cloth, leather, parchment, and paper. In the vicinity is an extensive paper mill which gives employment to 200 persons. Pop. 11,000. This was a very celebrated city of the Volsci, and afterwards came into the possession of the Samnites, from whom it was taken by the Romans in B.C. 305. During the latter period of the Roman Republic it was a flourishing municipal town; but it is chiefly distinguished as the birthplace of two of the most illustrious men in Roman history, Caius Marius, and Marcus Tullius Cicero. The latter frequently alludes to Arpinum in his letters, and describes the inhabitants as rustic and simple in their manners, but possessing many virtues. His favourite villa was situated in a plain beneath the town, on the banks of the little river Fibrenus. Remains of the walls and of the ancient city are still to be seen.

ARQUA, a market-town of Austrian Italy, among the Euganean hills, in the delegation of, and 12 miles south-west from, Padua. Pop. 1000. Here Petrarch resided during the latter years of his life, and here he died on the 19th July, 1374. "His ashes are preserved in the churchyard of the town, in a sarcophagus of red marble, raised on four pilasters on an elevated base, and preserved from an association with meaner tombs."—

"They keep his dust in Arqua where he died;
The mountain village where his latter days
Went down the vale of years; and 'tis their pride—
An honest pride—and let it be their praise,
To offer to the passing stranger's gaze
His mansion and his sepulchre; both plain
And venerably simple, such as raise
A feeling more accordant with his strain
Than if a pyramid formed his monumental fane."

"The house in which Petrarch resided is on the edge of a little knoll overlooking two descents, and commanding a view, not only of the glowing gardens in the dales immediately beneath, but of the wide plains, above whose low woods of mulberry and willow, thickened into a dark mass by festoons of vines, tall single cypresses and the spires of towers are seen in the distance which stretches to the mouth of the Po and the shores of the Adriatic. The chair in which the poet breathed his last is still shown among the precious relics of Arquà."—*Childe Harold*, canto iv. st. 31, and note 9.

ARQUES, a small decayed town of France, department of Seine Inferieure, on a navigable river of the same name, 3 miles south-east of Dieppe. It was once a very considerable place, and its castle, now in ruins, was an important stronghold in the middle ages. In the vicinity of this town Henri IV., with about 6000 or 7000 men, gained a victory over the army of the league, consisting of 30,000, commanded by the Duke of Mayenne, on the 21st Sept. 1589. The victory was severely contested, and Henri had encountered many personal dangers, when the arrival of the Count of Châtillon at the head of 500 arquebusiers decided the fate of the day.

ARRACAN, a maritime province of Eastern India. It was formerly an independent kingdom, but fell by conquest to the Burmese in 1783, and was by them ceded to the British in 1826. It is distributed into the districts of Akyab, Ramree, and Sandoway; and is bounded by the Chittagong district on the north, from which it is separated by the small river Naaf; by the Yoomadoung range of mountains on the east, dividing it from Ava and the British district of Pegu; and on the south and west by the Bay of Bengal. It lies between Lat. 16. 2. and 21. 33.; and Long. 92. 10. and 94. 50. Its length from its northern extremity to Cape Negrais is about 400 miles; its greatest breadth is in the northern part, where it falls little short of 90 miles, but it gradually diminishes towards the south, until at the extreme point it tapers to a narrow strip not more than 15 miles across. The coast is studded with several islands, the most important and fertile of which are Cheduba, Ramree, and Shapoora. The Yoomadoung Mountains, forming part of the great chain stretching southward from Assam, attain a considerable elevation, averaging in this part from 3000 to 4000 feet, while one portion of the range called the Blue Mountain, situate about Lat. 22. 37. Long. 93. 11., rises 8000 feet above the level of the sea. Over these mountains there are several passes; that called the Aeng route, which leads from the village of that name to the Burmese capital, being superior to any of the others. On the summit of the ridge by this route, and immediately on the frontier line between the British and Ava territories, the Burmese had constructed the stockade of Nariengain. The fortification was originally of little consequence, deriving its importance solely from its position, which commanded the ascent as well from the side of Ava as from that of Arracan; but during the war of 1852 the Burmese had so added to the strength of the works that the place was deemed unassailable, except by mortars and rockets. A small force, however, under the command of Captain Nuthall, accompanied by Captain Sutherland, succeeded, on the night of the 6th January 1853, in arriving unobserved within a short distance of the spot. After a brief pause the men moved silently towards the stockade, and it being ascertained that the garrison were asleep, orders were given to charge the gate in force, and the fort regarded as impregnable was thus captured by surprise.

The principal rivers of the province are the Myoo, Kuladyne or Arracan River, Leyryo, Talak, and Ayeng. A range of hills of no great height skirts the sea-shore; and the adjacent valleys are covered with thick jungle, and filled with wild animals, among which are the elephant, tiger, leopard, bison, and wild hog; but the natural history of Arracan has not received much attention, and the cursory notices of travellers afford the only existing information. Owing to the moist temperature (the periodical rains continuing from May till October, and occasionally to December) this tract of country is frequently flooded; and being much intersected by rivers and inlets of the sea, communication between the villages is generally maintained by means of boats. The soil is fertile, but the frequent rains and exhalations under the burning sun of the tropics are adverse to the European constitution. The staple produce is rice, of which the crops are represented as being the richest in India, and affording, in addition to the demand for home consumption, a large surplus for exportation. The other chief productions are sugar, cotton, tobacco, hemp, and indigo. The fruits, which are abundant and of superior quality, comprise pine-apples, plantains, mangoes, jacks, sweet limes, cocoa-nuts, and others requiring a tropical climate. The forests produce an abundance of excellent timber, the principal trees being oak and teak; but owing to the difficulty of conveyance from the hills, timber is usually imported from the district of Bassein. Salt is produced in great plenty by solar evaporation, and forms a principal article of exportation. Limestone is procured from the adjacent islands.

The aboriginal inhabitants of Arracan are termed Mughs, who with Burmans, Mussulmans, sundry hill-tribes, and immigrants from various places, constitute the population. If, as is generally believed, the increasing numbers of a people indicate a wise and benevolent government, Arracan bears testimony to the character of that under which it has been placed. At the period of its occupation by the British the population did not exceed 100,000. In 1831 it had increased

to 173,000, and in 1839 to 248,000. It is now upwards of 321,000. The Mughs follow in their religion the Bhuddist doctrines which are universally maintained throughout Burmah. The priests are selected from all classes of men, and one of their chief employments is the education of children. Instruction is consequently widely diffused, and few persons, it is said, are found in the province who are unable to read. The qualifications for entering into the priestly order are good conduct and a fair measure of learning; such conduct at least as is good, according to Bhuddish tenets, and such learning as is esteemed among their votaries. Polygamy is in general practice.

The natives of Arracan trace their history as far back as A.D. 701, and give a lineal succession of 120 native princes down to modern times. According to them their empire had at one period far wider limits, and extended over Ava, part of China, and a portion of Bengal. This extension of their empire is not, however, corroborated by any known facts in history. At different times the Moguls and Peguers carried their arms into the heart of the country. The Portuguese, during the era of their greatness in Asia, gained a temporary establishment in Arracan. But in 1783 the province was finally conquered by the Burmese; from which period until its cession to the British in 1826 under the treaty of Yandaboo, its history forms part of that of Burmah.

The old city of Arracan, formerly the capital of the province, is situate on an inferior branch of the Kuladyne River. Its remoteness from the ports and harbours of the country, combined with the extreme unhealthiness of its locality, have led to its gradual decay subsequently to the formation of the comparatively recent settlement of Akyab, which place is now the chief town of the province. Arracan is distant north-east from Akyab fifty miles; Lat. 20. 42. Long. 93. 24. (E. T.)

ARRACK. In India every kind of spirituous liquor is known under the general appellation of arrack; and hence the various accounts given of the mode of making it, and the materials used. The manufacture of arrack was formerly carried on by the Portuguese at Goa, but has been transferred for the most part from that place to Batavia. At Goa there are different kinds; single, double, and treble distilled. The double distilled, which is that commonly sent abroad, is weak compared with Batavia arrack; yet, on account of its peculiar and agreeable flavour, is preferred to all the other arracks of India. This flavour is attributed to the earthen vessels used to draw the spirit; whereas at Batavia they use copper stills.

The Pariah arrack made at Madras, and the Columbo and Quilone arrack at other places, being fiery, hot spirits, are little valued by the Europeans, though highly prized among the natives.

The Goa arrack is obtained by a double process of distillation from a vegetable juice called toddy, which flows by incision from the cocoa-nut tree. The liquor thus obtained holds but a sixth, and sometimes an eighth part of alcohol, or pure spirit.

Batavia arrack is obtained by distillation from rice and sugar. A fiery spirit called samshew, which is mixed with arrack, is imported into Batavia from China, chiefly for the use of the Chinese settlers.

ARRAGON. See ARAGON.

ARRAIGNMENT, in *Law*, the arraigning or setting a thing in order, as a person is said to arraign a writ of novel disseisin, who prepares and fits it for trial; but this term more properly denotes the calling of a person to answer in form of law upon an indictment, &c.

ARRAN, an island on the west coast of Scotland, near the mouth of the river Clyde, which forms part of the county of Bute. It is about 20 miles in length, by from 8 to 11 in breadth, and contains a superficial area of 165 square miles, or 105,814 acres, of which about 14,431 are cultivated. This island is of an extremely rugged and mountainous surface, particularly in the northern part, in which the valleys are deep and romantic. The principal mountain is Goatfell, which rises, according to accurate measurement, 2945 feet above the level of the sea, and is clothed with lichens and mosses. A few others approach to the same elevation. There are five small lakes and several streamlets in the island.

The quadrupeds are not numerous. A few red deer, the remains, it is said, of a numerous breed, still find shelter among the mountains; and wild goats are still harboured in those parts. The cattle and sheep, which were formerly small, have been improved by the introduction of a larger breed. The birds are, eagles, hooded crows, plovers, curlews, black cock, and other species of grouse, which are exceedingly numerous in the mountains. Ptarmigans, which were formerly seen, have now disappeared. Limestone, marl, and slate, are found in different parts, and there are also indications of coal; while in the mountains are found marble, jasper, agates, cairngorms, and a fine species of rock-crystal called the Arran diamond. A considerable manufacture of sulphate of baryta as a pigment has been carried on in Glen Sannox for several years. The geology of the island is an epitome of that of Scotland. The mountains of the north, especially Goatfell, consist of granite, covered on the flanks by mica slate, a red sandstone conglomerate, especially on the eastern shores, and may be traced easily around the whole island. On the eastern side carboniferous lime is found at several points, chiefly at Corrie, where several strata divided by shale, resting on a white sandstone, are quarried. In the southern part of the island an extensive trap formation is the chief visible rock. Several beds of anthracite were formerly worked on the north-east coast. This coal formation rested on the red sandstone, and was covered by white sandstone. Numerous veins of most beautiful pitchstone and pitchstone porphyry traverse the red sandstone, especially at Drimodoon, and between Brodick and Lamlash. Shoals of herring frequent the shores, and the herring fishery is prosecuted to a great extent, no fewer than 200 fishing-vessels, well-manned and properly fitted out, and belonging to the island, being employed in it. Arran has two remarkably fine harbours, Lamlash on the east, and Loch Ranza on the north-west side. Flax is cultivated in small quantities, and linens and some woollens are manufactured. About two-thirds of the island belong to the Duke of Hamilton, who takes much interest in its improvement, and has expended a considerable sum in making roads, bridges, and small harbours.

Brodick Castle, beautifully situated on an eminence surrounded by waving plantations, remained in ruins until the year 1845, when its noble proprietor, the Duke of Hamilton, completed, with great good taste, its reconstruction on the model of the ancient fortress. At the time of the memorable interregnum when Edward I. was endeavouring to crush the spirited efforts of Wallace and Bruce for the independence of their country, it was taken and held by the English under Sir John Hastings. It did not, however, remain long in their possession; "for James, Lord Douglas, who accompanied Bruce to his retreat in Rachrin, seems in the spring of 1306 to have tired of his abode there, and set out accordingly, in the phrase of the times, to see what adventure God would send him. Sir Robert Boyd accompanied him; and his knowledge of the localities of Arran appears to have directed his course thither. They landed on the island privately, and appear to have laid an ambush for Sir John Hastings, the English Governor of Brodick, and surprised a considerable supply of arms and provisions, and nearly took the castle itself. When they were joined by Bruce, it seems probable that they had gained Brodick Castle. At least tradition says that from the battlements of the tower he saw the supposed signal fire on Turnberry nook." After the settlement of the Scottish crown by Bruce, the castle of Brodick, as well as the greater part of Arran, was the property of the High Steward of Scotland, who, by failure of male-heirs to Bruce, succeeded to the throne under the title of Robert II. In 1455, it was stormed and levelled to the ground by the Earl of Ross, who had espoused the cause of the Earl of Douglas against his sovereign. Its next possessor was Sir Thomas Boyd, a court favourite, who married King James I.'s eldest sister, and received from that monarch the earldom of Arran as her marriage dowry. On the disgrace of the Boyds, Sir Thomas was divorced from his royal spouse, and the princess's hand, with her earldom of Arran, bestowed upon Lord Hamilton, in whose family, with the exception of a few interruptions, it has remained until this day.

Brodick Bay is a beautifully curved plain, girt with a beach of sand, and ornamented with neat cottages and villas, flourishing plantations, and cultivated fields, which, as they retire inwards,

are met by the wildly-contrasting valleys of Glenrosa, Glensheraig, and Glencloy. In Glencloy are the remains of an ancient fort, which tradition points out as having afforded shelter to Bruce's partizans, who had arrived in Arran before himself, while Brodick Castle was in the possession of the English; and at the head of the glen there are also the supposed remains of a Druidical circle.

About five miles from Brodick, in the middle of a beautiful semicircular bay, lies the neat little village of Lamlash. Sheltered by the Holy Island—an irregular cone 900 feet high—this bay forms an excellent harbour for the accommodation of ships of all sizes, while its surrounding scenery cannot be beheld without delight by all lovers of the picturesque.

The Holy Isle was once the site of an ancient cathedral, said to have been founded by St Molios, a disciple of St Columba, who not considering the discipline of Iona sufficiently rigid, retired for greater seclusion to this lonely isle, whence he carried the light of Christianity among the pagan inhabitants of Arran.

Behind the village of Lamlash are Glens Alaster and Meneadmar, at the head of which may be seen the remains of an ancient sepulchral cairn, measuring 200 feet in circumference. It is believed to cover the ashes of those who fell in a battle fought upon the spot; as on removing some of the stones, several stone coffins were found buried underneath. At the southerly point of the bay, about three miles from Lamlash, is King's-cross Point, whence Robert Bruce is said to have embarked for the coast of Carrick.

Near the basaltic promontory of Drimodoon, there are a number of water-worn caves, one of which, called the King's Cave, is famed for having been the residence of the patriot Bruce on his first arrival in the island. It is 114 feet long, 44 broad, and 47½ high. Some of the other caves are equally large; one is called the King's Kitchen; another his cellar; and a third his stable. The hill above the caves is called the King's Hill, from its connexion with Bruce. At the northern side of this hill, on the farm of Tormore, are the remains of a very perfect and interesting Druidical circle, called Suidhe choirr' Fhionn, or Fingal's Cauldron-seat.

Loch Ranza is about a mile in length, and, during the fishing season, is a place of great resort, 300 boats sometimes lying at anchor in the bay at the same time. The ruins of Loch Ranza Castle stand upon a small peninsula near the entrance of the Loch. This castle is not heard of until the year 1380, when it is enumerated among the royal castles, as a hunting-seat of the Scottish sovereigns. The roof having fallen in, it is now fast falling into decay.

Off the south-east point of Arran lies the low rocky islet of Pladda, with a lighthouse having two fixed lights, 130 and 77 feet above high-water, and visible 16 and 13 miles respectively, in clear weather. Lat. 55. 25. N. Long. 5. 7. W. Pop. in 1851, 8203.

ARRAN ISLES, a group of small islands off the coast of Galway in Ireland, constituting the barony of Arran. They are sometimes called South Arran, to distinguish them from the island of Arranmore or North Arran, in the county of Donegal. The three principal islands of the group are Arranmore or Inishmore, Inishmain, and Inishere. On the first is a lighthouse exhibiting a bright revolving light, 498 feet above high-water mark. Lat. 53. 7. 38. N. Long. 9. 42. 22. W. The bay of Killany, to the N. of the village of that name, is the principal harbour in the group. The inhabitants of these islands, amounting in 1851 to 3333, are employed in fishing and agriculture, and are much behind in education and improvement. The area of the whole group is 11,287 acres.

The Arran islands abound in antiquities and religious remains, and are said to have contained at one time no less than 20 churches and monastic establishments. Most of these were in the island of Inishmore, called by the natives *the Island of the Saints*. The circular fort of Dun-Angus, built of uncemented stones on a cliff overhanging the sea, is the most striking of these ancient remains. The holy wells, altars, groves, &c., are still visited by numbers of enthusiastic devotees.

ARRAS (the *Nemetacum* of the Romans), a fortified city of France, chief town of the arrondissement of the same name, and also of the department of Pas de Calais, and formerly capital of the province of Artois. It is situated on both sides of the Scarpe, where that river receives the Crinchon, 32 miles north-east of Amiens, and 100 miles N.N.E. of Paris. The town is well built, and adorned with many handsome edifices, such as the town-house, cathedral, citadel, arsenal, barracks, theatre, &c. Its fine old Gothic cathedral was utterly destroyed during the revolutionary phrenzy. It is the seat of a bishop, and of a court of assize; and has a royal society, a college, a diocesan seminary, an institution for the deaf and dumb, and schools of design and belles lettres. It has also a public library of 36,000 volumes, a picture gallery, museum, and botanical garden. Its chief manufactures are lace, woollens, hosiery, beet-root sugar, salt, soap, and earthenware; with a considerable general trade in wine, oil, grain, sugar, &c. The river Scarpe is navigable up to the town. Arras is the birthplace of the assassin Damiens, the two brothers Robespierre, and Lebon. Pop. in 1846, 24,321. Lat. 50. 17. 31. N. Long. 2. 46. 49. E.

Arras is very ancient, and was the chief town of the *Atrebates* as early as the time of Cæsar. (See ATREBATII.) In 407 it was destroyed by the Vandals, and afterwards by the Normans in 880. It gives name to a treaty concluded here between France and Burgundy in 1435, and to another in 1482, between Maximilian of Austria and Louis XI. of France, by which Burgundy and Artois were given to the Dauphin as a marriage portion. In 1493 it came again into the possession of Maximilian. In 1640 the troops of Louis XIII. took Arras; and by the peace of the Pyrenees in 1659, France was confirmed in the possession of the town.

ARRASWISE, in *Heraldry*, is used for the placing of any object of a square form in such a position as to exhibit a perspective view of its top and two of its sides.

ARRAY, in *Law*, the ranking or setting forth of a jury, or inquest of men impannelled on a cause.

ARRAYERS, ARRAGERS, or ARRAITORES, is used in some ancient statutes for such officers as had charge of the soldiers' armour, and their proper accoutrement. In some reigns commissioners were appointed for this purpose.

ARRENTATION, in the forest laws, implies the licensing the owner of lands in a forest to inclose them with a low hedge and a small ditch, in consideration of a yearly rent.

ARREOYS. Among the more singular secret societies which mankind have formed, was one in Otaheite and the neighbouring islands for the destruction of their own species, called *Arreoy*, *Arehoe*, or *Earowie*.

Whether Mendana, Quiros, and the earlier navigators of the South Pacific Ocean, discovered this society, does not appear: it was, at any rate, reserved for those of later date to unfold its principles and peculiarities, though its constitution is still enveloped in mystery, the members having been bound to the strictest secrecy.

The society of Arreoys consisted of hundreds or perhaps thousands of both sexes, who engaged to destroy their own offspring at the moment of birth. It was chiefly composed of persons distinguished by valour and merit, and hence one or more individuals of each family of the chiefs were of the number. All the men professed themselves warriors, and were in general stout and well made; the greatest trust and confidence were reposed in them; and it rather appears that the women consisted of the higher ranks only. There were different gradations in this community, which were recognized by the mode of tattooing: the more profusely the men were tattooed, the higher was their rank in society; the first were called *Ava bly areema tutowe*; 2. *Areema bly*; 3. *Ahowhoa*; 4. *Harrotea*; 5. *Eote ole*; 6, 7. *Po*; and youths training up were designed *Mo*; but the meaning of these names is not explained. By the fundamental laws of the society, the offspring must be destroyed, yet it is not known with certainty by whom or in what particular manner; the murder was always perpetrated in secret, probably by strangulation; all the attendants were excluded; for it is said, were they to witness it they would be adjudged guilty of participation, and put to death. Sometimes the mother, animated by natural affection, tried to preserve her infant, and resisted the persuasions of her husband and his brother Arreoys, who wished to consign it to destruction. But in general the enormity of the crime did not appal the females, though they are ascribed as affectionate and tender. We find a dancing girl pregnant by an Arreoy expressing herself thus to the English navigators: "Perhaps the

Arrest.

Etooa or deity of England might be offended with the practices of the Arreoys, but her own was not displeased with them. However, she promised if we would come from England for her child, she might perhaps keep it alive, provided we gave her a hatchet, a shirt, and some red feathers." That the rules of the community were very strict, may be inferred from an instance given by Captain Bligh. A chief, a member of the society, married a sister of the king of Otaheite, by whom he had eight children, and the whole were destroyed at their birth! Nor did this enormity seem to originate from any other source, as the parents afterwards adopted a nephew as their heir.

Probably the murderous practices of the Arreoys in the South Sea Islands originated in some religious principle; but it is the mission and the glory of Christianity to abolish the enormities of heathenism. Through the patient labours of Christian missionaries in Otaheite and other islands of the Pacific, many of the natives have been converted to Christianity; and such has been the influence on society at large, that the revolting practices of the Arreoys, with the monstrous and cruel rites of idolatry, have been banished from the islands which have been visited with the purifying light of the gospel.—See Ellis's *Polynesian Researches*, vol. i.

ARREST (from the French *arrester*, *arrêter*, to stop or stay), is the restraint of a man's person, for the purpose of compelling him to be obedient to the law, and is defined to be the execution of the command of some court of record or officer of justice.

Arrests are either in civil or in criminal cases.

I. *As to an arrest in civil cases.* The arrest must be by virtue of a precept or order out of some court, and must be effected by corporal seizing or touching the defendant's body, or as directed by the writ, *capias et attachias*, take and catch hold of. And if the defendant make his escape, it is a *rescous* or rescue, and attachment may be had against him, and the bailiff may then justify the breaking open of the house in which he is, to carry him away.

Arrests on mesne process, before judgment obtained, are, since the 1st and 2d Vict., c. 110, no longer allowable, except under special circumstances and under the authority of a judge's order. Such order may be obtained on an affidavit to the satisfaction of the judge that the defendant is about to leave the country.

A judgment creditor may arrest his debtor under a writ of *capias ad satisfaciendum*, but since the 7th and 8th Vict., c. 96, the debt must exceed L.20, exclusive of costs; and if the debtor does not make satisfaction he must remain in custody, until discharged under the acts for the relief of insolvent debtors.

The following persons are *privileged* from arrest: 1*st*, Peers of the realm; members of parliament, not only when the house is sitting, but for such a period before the first meeting and after the dissolution of a parliament as may enable them conveniently to come from and return to any part of the kingdom, and also for 40 days after every prorogation, and 40 days before the next appointed meeting. 2*d*, Peeresses by birth; peers of Scotland; peeresses by marriage; Irish peers; members of convocation actually attending thereon (8th Henry VI., c. 1). 3*d*, Bishops; ambassadors, or the domestic servant of an ambassador, really and *bona fide* acting in that capacity (7th Anne, c. 12); the Queen's servants, marshal, &c. 4*th*, Attorneys, witnesses subpœnaed, suitors, and all other persons, while necessarily attending the courts of justice, or going to or from the same (*eundo, morando, et redeundo*). 5*th*, Clergymen, performing divine service, and not merely staying in the church with a fraudulent design (50th Edward III., c. 5, and 1st Richard II., c. 16, as amended by 9th Geo. IV., c. 31).

The arrest of any privileged person is irregular *ab initio*, and the party may be discharged on motion. The only exception is as to indictable crimes, such as "treason, felony, and breach or surety of the peace."

There are now no longer any places where persons are privileged from arrest, such as the Mint, Savoy, Whitefriars, &c., on the ground of their being ancient palaces. See statutes 8th and 9th Will. III., c. 27, § 15; 9th Geo. I., c. 28, § 1; 11th Geo. I., c. 22; as amended by 1st Geo. IV., c. 116.

Except in cases of treason, felony, or breach of the peace, an arrest cannot be made on a Sunday, and if made it is void (29th Car. II., c. 7); but it may be made in the night as well as in the day.

II. *As to an arrest in criminal cases.* All persons whatsoever are, without distinction, equally liable to this arrest, and any man may arrest without warrant or precept, and outer doors may be broken open for that purpose.

The arrest may be made, 1*st*, by warrant; 2*d*, by an officer without warrant; 3*d*, by a private person without warrant; or, 4*th*, by a hue and cry.

1. Warrants are ordinarily granted by justices of the peace on information or complaint in writing and upon oath, and they must be indorsed when it is intended they should be executed in another county (see 11th and 12th Vict., c. 42). They are also granted in cases of treason or other offence affecting the government by the privy council, or one of the secretaries of state, and also by the chief or other justice of the court of Queen's bench in cases of felony, misdemeanour, or indictment found, or criminal information granted in that court.

2. The officers who may arrest without warrant are,—justices of the peace, for felony or breach of the peace committed in their presence; the sheriff and the coroner in their county for felony; constables for treason, felony, or breach of the peace committed in their view,—and within the metropolitan police district they have even larger powers; and watchmen from sunset to sunrise.

3. A private person is bound to arrest for a felony committed in his presence, under penalty of fine and imprisonment.

4. The arrest by hue and cry is where officers and private persons are concerned in *pursuing* felons, and such as have dangerously wounded another.

The remedy for a wrongful arrest is by an action for false imprisonment. (R. M—M.)

In Scotland the law of arrest in criminal procedure has a general constitutional analogy with that of England, though the practice differs with the varying character of the judicatories. Colloquially the word arrest is used in compulsory procedure for the recovery of debt; but the technical term applicable in that department is Caption, and the law on the subject is generically different from that of England. There never was a practice in Scottish law corresponding with the English arrest in mesne process; but by old custom a warrant for caption could be obtained where a creditor made oath that he had reason to believe his debtor meditated flight from the country, and the writ so issued is called a warrant against a person *in meditatione fugæ*. Imprisonment of old followed on ecclesiastical cursing, and by fiction of law in later times it was not the creditor's remedy, but the punishment of a refractory person denounced rebel for disobedience to the injunctions of the law requiring fulfilment of his obligation. The system was reformed and stripped of its cumbrous fictions by an act of the year 1837. Althougth the proceedings against the person could only follow on completed process, yet, by a peculiarity of the Scottish law, documents executed with certain formalities, and by special statute bills and promissory-notes, can be registered in the records of a court for execution against the person as if they were judgments of the court. In 1835 imprisonment for debts not exceeding a hundred pounds Scots or L.8, 6s. 8d. was abolished. (J. H. B.)

Arrest of Judgment.

Arrest *of Judgment* is the assigning just reason why judgment should not pass, notwithstanding verdict given, either in civil or in criminal cases, and from intrinsic causes arising on the face of the record.

Under the New Common Law Procedure Act, 15th and

16th Vict., c. 76, § 143, the omitted facts, however, may, by leave of the court, be suggested. Although these motions are not abolished altogether, they will therefore not be fatal as heretofore, but the truth of the suggested facts omitted will be tried and judgment be given thereon; and this judgment will have the same effect, under section 144, as if the suggested facts were in the original pleadings. (R. M—M.)

ARRESTMENT, in *Scottish Law*, denotes that process by which a creditor detains the goods or effects of his debtor in the hands of third parties till the debt due to him shall be paid. It is divided into two kinds,—1*st*, Arrestment in security, used when proceedings are commencing, or in other circumstances where a claim may become, but is not yet enforceable; and 2*d*, Arrestment in execution, following on the decree of a court, or on a registered document under a clause or statutory power of registration, according to the custom of Scotland. By the process of arrestment, the property covered by it is merely retained in its place—to realize it for the satisfaction of the creditor's claim a farther proceeding called Forthcoming is necessary. By old practice, alimentary funds, or those necessary for subsistence, were not liable to arrestment. By a statute of 1837, the wages of labourers and manufacturers, so far as necessary to their subsistence, are declared not to be arrestable. The question of necessity for subsistence is decided according to the discretion of the judge resorted to. This restriction was enacted on account of serious doubts whether this remedy, unknown in other parts of the empire, did not tend to foster a system of credit among the working classes, which put them at the mercy of petty dealers, and disturbed the business of their employers, in whose hands their wages were arrested. It is still a question much debated, whether the remedy—limited though it be by the act of 1837, and by an act of 1845, abolishing arrestments of wages in *dependence* in small-debt actions—is not liable to abuse. (J. H. B.)

ARRHÆ, money given by the purchaser in evidence of the completion of a bargain. Hence the Scottish term *Arles*, which, however, is not recognized in law.

ARRIA, the heroic wife of Cæcina Pætus, who, when her husband was ordered by the Emperor Claudius to destroy himself and hesitated to do so, stabbed herself, and presented the dagger to him with these words—"*Pæte, non dolet*"—(Pætus, it does not pain me).—Plin. *Ep.* iii. Dion Cass. lx.

ARRIAN (Ἀῤῥιανός), a distinguished Greek historian and philosopher, who lived in the time of the Emperors Hadrian, Antoninus Pius, and Marcus Aurelius. He was a native of Nicomedia, born about the end of the first century of our era, and was one of the most distinguished disciples of the famous Epictetus. In A.D. 124, he lived at Athens, where he made the acquaintance of the Emperor Hadrian, who was so much struck with his practical wisdom as to raise him to several high offices; and under Antoninus he obtained even the consulship. The only other event of his life of which we know anything is, that he was appointed governor of Cappadocia. Arrian himself proudly disdains giving us any information of himself; and his life, written by Dion Cassius, is lost.

History and philosophy are greatly indebted to Arrian; for, being a disciple of Epictetus, who himself did not write any work, Arrian determined to be to him what Xenophon had been to Socrates, and published his philosophical lectures in eight books, of which only the first half is extant; but the portion which has come down to us gives us a most exalted view of the ethical philosophy of Epictetus and the Stoics generally. The work bears the title Διατριβαὶ Ἐπικτήτου, and is contained in Schweighaüser's *Philosophiæ Epicteteæ Monumenta*, vol. iii. A second work, by which Arrian testified his attachment to his great master, bears the title Ἐγχειρίδιον Ἐπικτήτου, a short manual of moral philosophy, compiled from the lectures of Epictetus, which for many centuries was regarded both by Pagans and Christians as the best book on the subject. It has been published in a great many editions: the best is in the collection of Schweighaüser, mentioned above.

Among Arrian's own original works, the first and foremost is his account of the expedition of Alexander the Great in seven books. It contains the best and most authentic account of that conqueror's career, being based upon the lost works of Aristobulus and Ptolemy, the son of Lagus, both of whom accompanied the king during the expedition. Editions: J. Gronovius, Lugd. Bat. 1704, fol.; Schmieder, Lipsiæ, 1798, 8vo; Ellendt, *Regim. Pruss.* 1832, 2 vols. 8vo; Krüger, Berlin, 1835 and 1848, 2 vols. 8vo; 1851, 1 vol. 8vo; and Sinteius, Lips. 1849. Connected with this is a treatise on India, in the Ionic dialect, which he wrote separately, in order not to be obliged to interrupt the history of Alexander. Besides these, he wrote a work on the chase, a periplus of the Black Sea, and a manual of tactics; but many other works which are ascribed to him by the ancients have not come down to us. Certain descriptions of the coasts of the Sea of Azov and the Red Sea, which are ascribed to him, are probably the productions of a later period.

Arrian's style is simple, lucid, and manly; and his imitation of Xenophon is visible, not only in his style and diction, but even in the subjects on which he wrote. His language, though pure Attic, presents some peculiarities which are not found in the works of his great model. (L. S.)

ARRIAZA, JUAN BAUTISTA, a modern Spanish poet of considerable reputation, was born in 1770, at Madrid. He published his *Primicias*, an anonymous volume, in 1797. He was secretary to the Spanish embassy at London, where he wrote his *Emilia*. He then went at Paris; returned home in 1807; and became a violent partizan of the service party, attacking the Cortes and the patriots in prose and verse in his *Discursos Politicos*, and *Poesias Patrioticas*. His style is better than his subject, and his verses display harmony and expression. He died in 1837 at Madrid.

ARRIEGE. See ARIEGE.

ARRIS. See ARCHITECTURE.

ARRIS-FILLET, or *Tilting-fillet*, a triangular piece of wood used to raise the slates or lead of a roof against the shaft of a chimney or a wall, in order to throw off the rain more readily. The term arris is also applied to a wooden gutter in the form of a V.

ARROE, a small fruitful island in the Baltic, 10 miles south of Fuhnen. It is 14 miles long, averaging 5 in breadth, and has a population of 10,000. It belongs to Denmark. Lat. 54. 54. N. Long. 10. 20. E.

ARROW, a missile weapon of offence, slender pointed and sometimes barbed, to be cast or shot with a bow. See ARCHERY.

ARROW-Makers were formerly called *fletchers*, and, as well as bowyers, were persons of great consequence in the commonwealth.

ARROW, more properly ARREE, ROOT, is the name given to the farina obtained from two species of Scytaminean plants, *Maranta arundinacea*, and *M. indica*; the former coming to us from the warmer regions of the New World, the other from the East Indies. It is largely used as a food for infants, and for persons with delicate stomachs, or subject to diarrhœa. It is a pure starch, soluble in cold water, and forms a viscid, clear solution with warm water. With milk it forms an excellent pudding.

The quantity of arrowroot imported to Britain in 1852, from British possessions, was 364 cwt. 3 qr. 18 lb.; from foreign countries, 736 cwt. 3 qr. 4 lb. Till 1853 there was a duty of 6d. per cwt. on the former, and 2s. 6d. on the latter, now reduced to the uniform rate of 4½d.

ARROWSMITH, Aaron, an eminent geographer and hydrographer, born at London in 1750. He published, in 1817, a new General Atlas, 4to, and produced a great number of maps and charts. His map of the world on Mercator's projection is much esteemed. He died in 1823.

ARSACES VI., otherwise Mithridates, a king of the Parthians, spoken of in the First Book of Maccabees. He considerably enlarged the kingdom of Parthia by his good conduct and valour. There were thirty-one kings of the dynasty of the Arsacidæ. See Vaillant, *Arsacidarum imperium, sive regum Parthorum historia ad fidem numismatum accommodata.* Paris, 1725.

ARSENAL (from the Romaunt *arthenal*, a citadel), originally denoted exclusively a magazine of naval stores and warlike apparatus, giving probability to the etymology which derives the word from the Latin *arx navalis*, a naval citadel. Now, however, the term is applied to a repository of warlike stores, whether for land or sea service. The naval arsenals are, however, still the more numerous, and will be found described at length under the article Dockyards.

The great arsenal of Britain (if we except the Tower) is that of Woolwich, where all warlike stores and apparatus are not only preserved, but manufactured in the immense buildings devoted to the purpose. (See Woolwich.) Deptford, Chatham, Sheerness, Portsmouth, and Plymouth, are the great naval arsenals. In France, there are military arsenals at Paris, Strasburg, Metz, Lille, &c., and five great maritime arsenals, the chief of which are those of Brest, Toulon, and Rochefort; next to them L'Orient and Cherbourg. There are also inferior arsenals at Dunkirk, Havre, Saint Servan, Nantes, Bordeaux, and Bayonne. The other principal naval arsenals in Europe are those of Russia, at St Petersburg, Cronstadt, and Sebastopol; of Holland, at Anvers, Flushing, Helvoetsluys, and the Texel; of Prussia, at Danzig; of Hamburg; of Denmark, at Copenhagen; of Turkey, at Constantinople; of Italy, at Genoa, Villa-franca, Livorno, Spezzia, Civita Vecchia, Naples, Ancona, Venice, and Trieste; of Spain, at Cadiz, Carthagena, and Barcelona, and the British one at Gibraltar; of Portugal, at Lisbon; of Britain, at Malta and Corfu, &c. The principal naval arsenals of the United States are at New York, Boston, and Baltimore; of Brazil, at Rio Janeiro and Bahia; of La Plata, at Buenos Ayres and Monte Video; of Chili, at Valparaiso; and of Mexico, at Vera Cruz.

ARSENIC, a metal, the salts of which are deadly poisons. See Mineralogy, Medical Jurisprudence, and *Index*.

ARSENIUS, a deacon of the Roman Church, of great learning and piety. He was appointed by the pope to go to the Emperor Theodosius, as tutor to his son Arcadius. Arsenius arrived at Constantinople in the year 383. The emperor happening one day to go into the room where he was instructing Arcadius, his son was seated and the preceptor standing. At this he was exceedingly displeased, took from his son the imperial ornaments, made Arsenius sit in his place, and ordered Arcadius for the future to receive his lessons standing uncovered. Arcadius, however, profited little by his tutor's instructions, for some time after he formed a design of despatching him. The officer to whom Arcadius had applied for this purpose divulged the affair to Arsenius, who retired to the deserts of Scete, where he passed many years in exercises of devotion. He died at Troë, aged 95.

ARSINOE, mother of Ptolemy I., was a concubine of Philip of Macedon, who gave her in marriage, while pregnant, to Lagus. The name was afterwards borne by several of her descendants, and was also given to various cities. See Egypt.

ARSON is the malicious and wilful burning of the house or outhouse of another man, or wilfully setting fire to one's own house, if a neighbour's house be also burnt.

To constitute the offence, there must be an intent to injure or defraud some other person; and, therefore, if a house is fired by negligence or mischance, it does not amount to arson, but is only a trespass.

The crime of arson attaches in the following instances:—1*st*, Unlawfully and maliciously setting fire to any dwelling-house, any person being therein. For this crime the offender is liable to the punishment of death. 2*d*, Unlawfully and maliciously setting fire to any church or chapel, or to any chapel for the religious worship of persons dissenting from the united church of England and Ireland, or to any house, stable, coachhouse, outhouse, warehouse, office, shop, mill, malthouse, hopsast, barn, or granary, or to any erection used in carrying on any trade or manufacture, or any branch thereof, whether in the possession of the offender or any other person, with intent to injure or defraud any person. The punishment for this offence is transportation for life, or for not less than fifteen years, or of imprisonment not exceeding three years (7th Will. IV., and 1st Vict., c. 89, § 2). 3*d*, Unlawfully and maliciously setting fire to any hovel, shed, or fold, not attached to any house, or to any farm-building, or any building or erection used in farming land, or to any hay, straw, wood, or other vegetable produce, or to any implements of husbandry, being in any farm-house or farm-building, with intent to set fire to such farm-house or farm-building, subject to the like punishment (7th and 8th Vict., cap. 62). 4*th*, Unlawfully and maliciously setting fire to any station, or other building belonging to any railway, dock, canal, &c. For this the punishment is transportation for life, or for not less than seven years, or imprisonment, with or without hard labour, for not less than three years (14th and 15th Vict., cap. 19, § 8). 5*th*, And by the 9th and 10th Vict., cap. 25, § 7, any overt act to *attempt* to set fire, with such intent that, if the offence were complete, the offender would be guilty of felony and liable to transportation for life, shall be deemed felony, with a punishment of transportation for fifteen years, or of imprisonment for two years, although the same be not actually set on fire. And every male offender, under the statutes 7th and 8th Vict., cap. 62, and 9th and 10th Vict., cap. 25, if under the age of eighteen years, is also liable, at the discretion of the court, in addition to any other sentence, to be either publicly or privately whipped; 6*th*, Servants negligently or carelessly setting fire to houses or buildings, are, under the 14th Geo. III., cap. 78, § 84, liable to forfeit L.100, or in default, to be imprisoned for eighteen months with hard labour.

In Scotland, the offence equivalent to arson in England is known by the more expressive name of wilful fire-raising. The later statutes cited above do not apply to Scotland where the crime is punishable capitally by old consuetudinary law. The public prosecutor has the privilege, as in other such cases, of declining to demand capital punishment, and it is usual so to act when the burning has not taken place under conditions likely to endanger life. (R. M—M.)

ARSURA, a term used in ancient times for the melting of gold or silver, either to refine them or to examine their value. The method of doing this is explained in the Black Book of the Exchequer, ascribed to Gervaise, in the chapter *De Officio Militis Argentarii*, being in those days of great use, on account of the various places and different manners in which the king's money was paid.

Arsura is also used for the loss or diminution of the metal in the trial. In this sense a pound was said *tot ardere denarios*, to lose so many pennyweights.

Arsura is likewise used for the dust and sweepings of silversmiths, and others who work in silver melted down.

ART and PART, in *Scottish Law*, the aiding or abetting in the perpetration of a crime.

ARTA, a town of Albania in European Turkey, sandjak of Janina, situated on a river of the same name, and about seven miles from the Gulf of Arta. It has several mosques,

a number of Greek churches, a large cathedral, a ruined convent of the ninth century, now a caravansera; a citadel, some good houses and shops; and a fine old bridge over the river, consisting of an arch eighty feet high, and several smaller ones. It has about 8000 inhabitants, with manufactures of coarse cottons and woollens, leather, capotes, and embroidery; and the general trade is considerable. It is surrounded with gardens, orange-groves, and vineyards, and there is much wood in its vicinity. Arta occupies the site of the ancient Ambracia, and traces of its old walls are still to be seen. See AMBRACIA.

ARTA, GULF OF (the *Ambracius Sinus* of the ancients), a gulf of the Ionian Sea, in Lat. 39. N. Long. 21. E., having on the north Albania, and on the south and east Acarnania. Its length is 25, and its greatest breadth 10 miles, with a depth varying from 13 or 14 to 36 fathoms. Its entrance is only 700 yards across, outside of which is a bar composed of gravel, coarse sand, and sea-weed, with fifteen feet of water when shallowest. The north shore is for the most part low and swampy, and has encroached considerably on the water: the southern shore consists of high land with bold promontories, clothed with rich and extensive forests. It has been long celebrated for its excellent fish, of which the red and gray mullet are the most plentiful; and soles and eels also abound. The famous battle of Actium, which decided the fate of Augustus and Mark Antony, was fought near the entrance of this gulf in B.C. 31.

ARTABA, an ancient measure of capacity used by the Persians, Medes, and Egyptians. The Persian artaba is represented by Herodotus as equal to one Attic medimnus and three chœnices, or 102 Roman sextarii = about $12\frac{1}{4}$ gallons; but, according to Suidas, Hesychius, Polyænus (*Strat.* iv. 3, 32), and Epiphanius (*Pond.* 24), it only contained 1 Attic medimnus = 96 sextarii, or about $11\frac{1}{2}$ English gallons. The Egyptians used two measures of this name; the old artaba, containing $4\frac{1}{2}$ Roman modii = 72 sextarii = about $8\frac{3}{4}$ gallons, though Galen makes it exactly 5 modii; and the new artaba which contained $3\frac{1}{3}$ modii = $53\frac{1}{3}$ sextarii = about $6\frac{1}{2}$ gallons.

ARTABAZUS, the son of Pharnaces, commander of the Parthians and Chorasmians in the famous expedition of Xerxes. After the battle of Salamis he escorted his sovereign to the Hellespont with 60,000 chosen men; and after the battle of Platæa, in which Mardonius engaged in opposition to his wishes and advice, he made a noble retreat into Asia with 40,000 men under his command.

ARTAXERXES, the name of several kings of Persia. See PERSIA, and ESTHER.

ARTEDI, PETER, an eminent naturalist, was born in Sweden in the year 1705, in the province of Angermania. His parents were poor, but found means to give him a liberal education, and with this view sent him to the college of Hurnesand. Intending to embrace the ecclesiastical profession, he went in 1724 to Upsal; but he turned his attention to medicine from the strong bent of his mind for the study of natural history, in which science he made rapid progress, and soon rose to considerable eminence, particularly in the department of ichthyology, the classification of which he remodelled upon philosophical principles. This arrangement afterwards became popular over Europe. In 1728 his celebrated countryman Linnæus arrived in Upsal, and a lasting friendship was formed between these two great men. In 1732 both left Upsal; Artedi for England, and Linnæus for Lapland; but before parting, they reciprocally bequeathed to each other their manuscripts and books in the event of death. In 1735, however, they met again at Leyden, where Artedi was introduced to Seba, and employed in preparing for the press the third volume of that eminent naturalist's *Thesaurus*, which chiefly related to fishes. He intended, as soon as that work was finished, to return to his native country, and publish the fruits of his own labours: but as he was returning home from Seba's house on the evening of the 27th September 1735, the night being dark, he fell into the canal and was drowned. According to agreement, his manuscripts came into the hands of Linnæus, and his *Bibliotheca Ichthyologica* and *Philosophia Ichthyologica*, together with a life of the author, were published at Ledyen in the year 1738.

ARTEMIDORUS, a native of Ephesus, flourished, according to Reiff, in the reign of Marcus Aurelius. In his famous Treatise on the interpretation of Dreams (Ὀνειροκριτικά), he calls himself the *Daldian*, from Daldia or Daldis, the birthplace of his mother, by which name he is generally known, to distinguish him from Artemidorus the geographer, also a native of Ephesus. On this work he expended vast labour, not only possessing himself of all that had been written on the subject, but travelling for years in search of fortune-tellers, as well as corresponding with them in various parts, and collecting information on old dreams, and the events which were said to have followed them. It consists of five books, and contains some valuable observations on the maxims and customs of the ancients. The first edition is that of Aldus, 1518; the best that of Reiff, 2 vols. 8vo, Leipzig, 1805, with the notes of Rigault and Reiske. Artemidorus wrote also a treatise upon Auguries, and another upon Chiromancy, which are lost.

ARTEMIS, one of the chief divinities of Olympus, and worshipped under several forms in different parts of Greece and Asia Minor. The Ephesian Artemis was totally distinct from the Grecian goddess, and is supposed to have been originally an Asiatic divinity, the personification of the fructifying and all-nourishing powers of nature. The Romans identified Diana with the Greek Artemis. See DIANA.

ARTEMISIA, a queen of Caria, and daughter of Lygdamis, took part in person in the expedition of Xerxes against the Greeks, and distinguished herself in the sea-fight near Salamis, 480 B.C. She is said to have loved a young man named Dardanus, of Abydos; and enraged at his neglect of her, to have put out his eyes while he was asleep. The gods punished her for this, by increasing her passion; and having been advised by an oracle to go to Leucas, she is said to have taken the *lover's leap*, and to have been interred at that place. This part of her history, however, is probably fictitious.

ARTEMISIA, the sister and wife of Mausolus, king of Caria, immortalized herself by the honours which she paid to the memory of her husband. She built for him, in Halicarnassus, a very magnificent tomb, called the *Mausoleum*, which was one of the seven wonders of the world, and from which the title of *Mausoleum* was afterwards given to all tombs remarkable for their grandeur; but she died of regret and sorrow before it was finished. She appointed panegyrics to be made in honour of him, and proposed a prize of great value for the person who should compose the best. She died about 350 B.C.

ARTEMISIA, a botanical genus of the natural order of *Compositæ*; of which the best known are *A. Absinthium*, or wormwood, and *A. Abrotonum*, or southernwood.

ARTEMISIUM, in *Ancient Geography*, a promontory on the north-east of Eubœa (called *Leon* and *Cale Acte* by Ptolemy), memorable for the first sea engagements between the Greeks and Xerxes.

ARTEMON, a painter of antiquity, probably posterior to the time of Alexander the Great. Plin. xxxv. 11. There was also, in the first century after Christ, a sculptor of this name, who, with Pythodorus, adorned the palace of the Cæsars with statues. Plin. xxxvi. 5.

ARTEMON, a heretic of the second and third centuries, the founder of the sect called *Artemonites*, who applied philosophy and mathematics to the interpretation of Scripture.

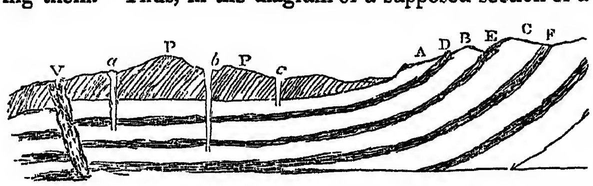
Artesian Wells.

They asserted that Christ was merely a prophet exalted by his virtues above all others, but denied his divinity. Euseb. *Hist. Ecc.* v. 28.

ARTESIAN WELLS, the name applied to artificial springs, produced by boring a small hole through strata destitute of water, into lower beds in which water is percolating in considerable quantity. On making such perforation, the water often rises forcibly to the surface, and is conveyed to a convenient receptacle by a pipe introduced by the perforation into the strata affording the water. The first place in Europe where such artificial fountains were extensively formed was in the French province of Artois, anciently *Artesium.* But there is reason to believe that the art was long before practised by the Chinese, who are very expert in the formation of such wells. They are extensively used in the Milanese, in several parts of Germany, and have also been for several years employed in the south of England, on the coast of Lincolnshire, and more lately in the vicinity of London.

An artesian well was sunk at Sheerness in 1781, to the depth of 330 feet (*Phil. Trans.* 1784). It was carried through a thick bed of *London clay*, and water, which rose nearly to the surface, was found on reaching the subjacent sand-beds. Two of better construction were carried to the same depth through similar materials at Portsmouth docks in 1828 and 1829.[1] The soil of the district on the coast of Lincoln between Lowth and the sea, rests on a thick bed of clay, which precludes the possibility of springs; but by penetrating through this, water was found in abundance in the chalk on which the clay reposed; and artesian wells there now afford a plentiful supply of this necessary element, that rises with such force through the pipes as to have obtained the local name of *blow-wells.*

The theory of artesian wells is founded on the fact that water derived from a higher level may percolate through certain strata, or pass in seams between them, and be prevented from reaching the surface by the superposition of other beds or strata impervious to water. In such circumstances a perforation through the latter allows the water, by hydrostatic pressure, to reach the surface; and it will overflow, or even gush out, with a force proportional to the difference of level of the different parts of the water-bearing strata, especially if the free course of the subterranean sheet of water be interrupted by what are termed *faults* in the strata, or the occurrence of veins of stony bodies intersecting them. Thus, in the diagram of a supposed section of a



country, let P P represent a thick bed of plastic clay, A B C strata affording water, alternating with strata D E F, impervious to water, and let V represent a vein of trap rock traversing these strata, and producing a *shift* or fault; by sinking the pipes a b c into the strata A B C respectively, we shall obtain the water derived from the more elevated portions of these strata at such artesian fountains.

The same principles are applicable to the sinking of common wells. It has sometimes happened that a well has been lost in attempts to increase its flow by a deeper excavation. Thus, if the bottom of the well was a bed of clay resting on sand, a perforation made through that clay has occasionally lost all the water; because the stratum of clay had prevented the water from escaping to a lower level, and conducted it towards the surface. The direction of the strata, as well as their nature, are essential elements for the successful formation of either common or artesian wells; which last are of great consequence in champaign countries, where natural springs are less common.

Artesian wells have been also sunk for the purpose of obtaining *warm* water. It is well ascertained that in the interior of our earth there is a source of heat, which may be reached by deep artesian perforations, so as to bring warm water to the surface. Thus Von Bruckmann of Würtemburg heated a paper manufactory at Heilbronn by water from a deep artesian well; and by the same means prevented the freezing of the water in winter round the wheels of mills. In the artesian well at Rochelle, at the depth of 370 feet, the water has a temperature 13° higher than that of the atmosphere. M. Arago was the chief promoter of the artesian well in the plain of Grenelle at Paris, which, at the depth of upwards of 1900 feet, affords water at 92° F. In the deepest artesian well yet made, that at Kissingen, the temperature of the water is also very considerable.

The instrument now used in making artesian perforations to great depths is not the old machine employed in boring for coal, &c., a series of iron rods screwed together, and forced down by repeated blows with a mallet. That was a costly and tedious operation: a Chinese instrument has lately been introduced with great effect. It consists of a heavy bar of cast iron, 6 feet long and 4 inches in diameter, armed at its lower end with a cutting chisel, surrounded by a cylindrical chamber, which, by means of simple valves, receives and retains the abraded portions of the rock. The instrument is suspended by a rope passing over a wheel. As it is wrought up and down, the torsion of the rope gives a circular movement to the bar of iron, sufficient to vary the position of the chisel at each stroke of the instrument; and when the chamber is full of the debris of the rock, it is drawn up and discharged. This mode of working has greatly diminished the labour and expense of such operations; and is applicable to many processes in mining, blasting in quarries, and the like.

An ingenious German engineer, M. Sellow, has by a similar instrument of greater size, succeeded in ventilating the mines at Saarbrück, by perforations 18 inches in diameter, and several hundred feet in depth.

The importance of artesian wells can scarcely be over-estimated. They are capable of rendering districts now scantily supplied with or destitute of potable water, convenient domiciles for man; and under an enlightened government might render habitable no small portions of the arid wastes of Africa and Arabia. In the latter, recent observations show that there are abundant subterranean sources of water, and possibly a series of artesian wells might diminish the perils of the passage of the Great Sahara.—See Hericat de Thury, *Considerations sur la cause du Jaillissement des Eaux des Puitsforés,* Paris, 1829; Von Bruckmann, *Ueber Artesische Brunnen,* Heilb. 1833; M. Arago, *Notices Scientifiques,—Annuaire du Bur. des Long. pour Annes plus.* (T. S. T.)

Artevelde.

ARTEVELDE, JAMES VAN, a brewer of Ghent, in the fourteenth century, who, by means of his enormous wealth and popular talents, acquired such an ascendancy over his countrymen that he was enabled to expel the Count of Flanders, and assume absolute power. He formed a commercial alliance with Edward III. of England, and persuaded the English to lend him assistance in his war with France. The French, however, prevailed; and Artevelde, who now began to dread the vengeance of the Count of Flanders, en-

1 The first artesian well in London was sunk in 1794. Examples of the same may be seen at the Bishop's palace at Fulham, and several in the town of Brentford.

deavoured to secure the interest of the English in his favour by transferring the sovereignty of Flanders to the Prince of Wales. This he attempted to effect by force; but the people beset his house and assassinated him. After this event, which took place in 1345, the Prince of Wales returned to England.

Philip Van Artevelde, son of the preceding, was raised to the sovereignty during a revolt of the people in 1382. He defeated the Count of Flanders, and obtained possession of Bruges; but, in November of the same year, he was defeated and slain by the count, assisted by the French, in a battle fought near Rosbecq, and his body was ignominiously hung on a tree.

ARTHRITIC, a term applied by physicians, in a restricted sense, to painful affections of the joints arising from gout. The word is derived from αρθρον, a joint.

ARTHUR, the celebrated hero of the Britons, is said to have been the son of Uthor Pendragon, king of Britain, by Igerne, the wife of the Duke of Cornwall, and to have been born in 501. His life is a continued series of wonders. It is said that he killed 470 Saxons with his own hand in one day; and, after having subdued many mighty nations, and instituted the order of the Knights of the Round Table, died A. D. 542, of wounds which he received in battle. The most particular detail of his story and his exploits is that given by Geoffroy of Monmouth; but there the probable is so blended with the marvellous and extravagant, that not only the truth of the whole, but even the reality of Arthur's existence, has been called in question. In this controversy Mr Whittaker has taken much pains, in his *History of Manchester*, to vindicate the existence, and discriminate between the real and the fabulous transactions, of the British worthy. But a severe critic might be apt to say that it requires much faith in the author's judgment, not to suspect that he sometimes allows too much scope to fancy and conjecture. According to Mr Whittaker, Arthur's principal exploits were against the northern Saxons, whilst he was only prince of the Silures, and Ambrosius was the dictator or pendragon of the Britons. "In a series probably of five campaigns, and in a succession certainly of eleven victories, this great commander had repelled the Saxons from the north of Flavia, dislodged them from all Maxima, and dispossessed them of all Valentia. And these were successes so unchequered with misfortunes, so great in themselves, and so beneficial to the public, that the name of Arthur claims the first rank in the list of military, and the better one of patriot, heroes." The twelfth battle of Arthur was fought in the south of England, after he was elected to the pendragonship, against Cerdic the Saxon. "This," says Mr Whittaker, "was a most extraordinary victory, and completes the circle of Arthur's military glories." In the author's account of this prince's conduct in peace, he asserts, that "Arthur saw that an appointment was wanted, which should at once be a more regular and more honourable signature of merit—by the certainty of the honour and the greatness of the dignity, call out all the worth of all the worthy in the nation, and collect it round the throne of the pendragon. Accordingly he established a military order. It was the first that had ever been instituted in the island; and it has since been imitated by all the nations on the Continent. By means of this association, Arthur raised among the provincials a general glow of ingenuous heroism, the first spirit of chivalry that ever appeared in Europe; that manly and honourable gallantry of soul, which has made him and his worthies the subject of romantic histories over all the west of it. By this, and this alone, could he have been what history represents him, the Revered Father of the British Heroes in general, even to the conclusion of the sixth century, and nearly the middle of the seventh. The order naturally survived its founder; and the members of it were denominated the Warriors of Arthur, though the persons were born half a century after his death."—See also Sharon Turner's *History of the Anglo-Saxons.*

Arthur's Round Table, a round enclosure near Penrith, on the banks of the streamlet Loder. It is formed by a ditch and rampart of earth, 29 yards in diameter and is supposed to be an ancient place for tilting.—See Pennant's *Scottish Tour*, vol. i. p 277.

Arthur's Seat, a hill in the immediate vicinity of Edinburgh, said to have been so called from a tradition that King Arthur surveyed the country from its summit, and also defeated the Saxons in its neighbourhood. It rises by a steep ascent till it terminates in a rocky point, 822 feet three inches above high-water mark at Leith, as given by Moffat in his Levels of Edinburgh. From its summit the traveller may survey the centre of the kingdom, and obtain a complete view of Edinburgh, the whole forming a landscape varied and beautiful in a very high degree. Its rocky summit has some curious magnetical properties.

ARTICLE, in *Grammar*. See GRAMMAR.

ARTICULATA, Cuvier's third great division of the animal kingdom; including *Crustacea, Arachnides, Millipeds* or *myriapods*, and *Insects*, all which were comprehended by Linnæus under *Insecta.*

ARTIFICER, a person who works in iron, brass, wood, &c., such as smiths, brasiers, carpenters, &c. The Roman artificers had their peculiar temples, where they assembled and chose their own patron to defend their causes; and they were exempted from all personal services. Taruntenus Paternus reckons 32 species of artificers, and Constantine 35, who enjoyed this privilege. The artificers were incorporated into divers colleges or companies, each of which had their tutelar gods, to whom they offered their worship. Several of these, when they quitted their profession, hung up their tools, as votive offerings to their gods. Artificers were held a degree below merchants and *argentarii* or money-changers, and their employment more sordid. Some deny that in the earliest ages of the Roman state artificers were ranked in the number of citizens; others, who assert their citizenship, allow that they were held in contempt, as being unfit for war, and so poor that they could scarcely pay any taxes; for which reason they were not entered among the citizens in the censor's books; the design of the census being only to see what number of persons were yearly fit to bear arms and to pay taxes towards the support of the state. It may be added, that much of the artificers' business at Rome was done by slaves and foreigners.

ARTIFICIAL HORIZON, a contrivance of great utility for enabling an observer to determine the altitude of a heavenly body, or of a terrestrial object, above the horizon of any place, when the sensible horizon is ill defined. The surface of a fluid not easily disturbed by the air, such as quicksilver, or some viscid, opaque fluid, is usually employed for this purpose, as they will adjust themselves to a plane parallel to the rational horizon. To prevent the influence of winds in the open air, the surface is usually covered by a plate of ground-glass with parallel surfaces. In fixed observations this is not necessary; and the mercury is contained in an oblong trough: for locomotive observations, a cup of three inches in diameter is the containing vessel. But as carrying about mercury is inconvenient, some have employed polished metallic or glass mirrors, adjusted by screws at the corners, and a spirit-level, to horizontality; though this is less accurate than the fluid surface. The surface of the quicksilver, or mirror so adjusted, is a plane touching the surface of the earth where the observation is made, and parallel to the rational horizon; therefore, a ray of light passing from the object to the surface of the instrument, forms an angle with that surface equal to the angular elevation of that object above the true horizon of the place, when it is corrected for parallax and refraction.

ARTILLERY.

The term artillery, in modern warfare, is applied, in a special sense, to those projectile machines which, from their magnitude and weight, cannot be made the personal weapons of a soldier; and, in a general sense, to the officers and men, that is to say, to the *personnel* as well as to the *materiel* of that branch of the army to which the care and management of such machines have been confided. The origin of artillery, in the modern and special meaning of the term, may be simply ascribed to the substitution of a chemical for a mechanical agency in the projection of missiles of war; and the great superiority of modern artillery depends on the power of conferring great velocities on the bodies to be moved, by the sudden development of gaseous bodies from materials previously in a solid form. Notwithstanding the great improvements in modern machinery, it may be safely assumed, that by no application of the property of elasticity in metallic, wooden, or other springs, could a convenient machine have been formed to propel a 32-pound shot with a velocity of 1600 feet per second, although it is highly probable that one might have been constructed to propel very large masses with a low velocity, or to produce great momenta, as was in fact the case with some of the projectile machines of the ancients. Gunpowder, or the chemical agent now used in propelling warlike missiles, is a compound of nitre, charcoal, and sulphur, three substances which, under ordinary circumstances, retain the solid form, although intimately mixed together and in contact with each other. By the application of heat amounting to about 570° of Fahrenheit, by the electric spark, or by the shock between the bodies, and that not merely of iron against flint or other very hard body, but even of copper against copper, iron against marble, lead against iron or lead, provided the force of the shock be sufficient to develop the required amount of heat, the chemical affinities between the elements of these solid substances are excited; and they are almost instantaneously transformed into gaseous bodies in a state of great compression, and therefore endowed with an enormous elastic force. This chemical change is also accompanied with a great development of heat, which further tends to expand the gases; so that, at the moment of ignition, if considered instantaneous, the gases produced would be capable of expanding to a bulk 2000 times greater than the original volume of the gunpowder, or at that moment would exercise a force capable of reducing 2000 volumes to one. Such a force, if really exerted at its maximum of intensity, would require an enormous thickness, and therefore weight of metal, to resist its expansive effect; but the ignition of gunpowder, however rapid, is not instantaneous, and the ball, therefore, is put into motion, and the resistance of the air overcome before the perfect development of the gigantic power which is thus called into action.

In gunpowder, viewed theoretically, nitrate of potash, nitre, or saltpetre, is the reservoir of oxygen; charcoal, the element which, by its combination with oxygen, should form the gaseous body carbonic acid; and sulphur, the element which should facilitate ignition, and, by its affinity for the metallic base of potash, potassium, assist in inducing the decomposition of the nitre. The chemical formula which represents a compound which after ignition should yield only sulphuret of potassium, carbonic acid, and nitrogen, is $KONO^5 + 3\,C + S$, or, nearly, nitre 74·75, charcoal 13·34, sulphur 11·87; and though the gaseous product might be increased in volume by introducing sufficient carbon to produce carbonic oxide instead of carbonic acid, the gain in volume would be more than counterbalanced by the loss of heat.

The gunpowder of various nations approximates more or less to this normal composition.

England,...	*Nitre*	75·00	*Charcoal*	15·00	*Sulphur*	10·00
France, ...		75·00	...	12·50	...	12·50
Russia.		73·78	...	13·59	...	12·63
Austria, ...		76·00	...	11·50	...	12·50
Spain, ...		76·47	...	10·78	...	12·75
Sweden, ...		75·00	...	9·00	...	16·00
China, ...		75·00	...	14·40	...	9·60

It must not, however, be imagined that the result of ignition is exactly that which, from the theoretical formula, should be expected, as the products of combustion are more varied, and include, in addition to sulphuret of potassium, carbonic acid and nitrogen, portions of carbonic oxide, sulphuretted hydrogen, carburetted hydrogen, sulphide of carbon, sulphate and carbonate of potash, cyanide of potassium, and vapour of water; these products being the results of progressive, and therefore partial, ignition and decomposition. According to Dr Ure, the gaseous products of the combustion of gunpowder are carbonic oxide, sulphurous acid, and nitrogen; and there can be no doubt that the comparatively imperfect operation of chemical affinities between the particles of its solid constituents has a tendency to introduce more or less of sulphurous acid into the results by the direct combustion of the sulphur. Some of the modifications in the composition of gunpowder adopted by various countries have most probably been directed to a correction of this evil, as both sulphurous acid and sulphuretted hydrogen exert an injurious action on the metal of guns, more especially on that of bronze guns. As general rules, however, the sulphur must not be much less than the quantity of the theoretic formula, as, if so, the rapidity of ignition, and the amount of heat will be diminished; nor must it be much more, as, if so, the production of sulphurous acid will be increased, and with it the destructive effects on the gun; and in like manner the charcoal must not be much less, as, if so, there will be a defect of carbon for forming either carbonic acid or carbonic oxide; nor much more, as the gunpowder would, in addition to other defects, be thereby made too highly absorbent of moisture. When first made, gunpowder is in the state of fine dust, which is called meal powder, but as it is then liable to cake, and from the close packing together of its grains the rapid transmission of flame would be checked, the powder is granulated under a moderate force of compression, by which the grains acquire a greater density; and this quality being aided by glazing, they retain more effectually their form, and in some measure resist moisture, whilst the passage of flame through an assemblage of such grains is comparatively easy. Nothing but experience and practice can enable the manufacturer to decide the exact amount of compression or degree of glazing, as any material excess must injure the quality of the powder, by diminishing its combustibility.

The knowledge of an explosive force equivalent, according to Professor Graham, to at least 1000 atmospheres, and the power of readily applying it to practical uses, must very soon have led to important changes in the machines of war; and it might therefore have been expected that the exact epoch of its first employment would have been easily discovered. Such, however, is not the case, and there is still considerable uncertainty in the histories of gunpowder and of cannon. Colonel Chesney has most ably followed up the researches of M. Reinaud and M. Favé on the Greek fire of the ancients, and done much to establish the correctness of their opinion, that compounds of nitre were used at a very remote epoch, not merely for ignition, but also for explosion and propulsion. Passing over the earlier instances of the mention of "incendiary projectiles," amongst the natives of China and Hindustan, Colonel Chesney, quoting the fol-

lowing passage from Chased, a Hindu bard:—"Oh! chief of Gajné, buckle on your armour, and prepare your fire-machines;" the meaning of which is explained in a following stanza, in which the bard states "that the culivers and cannons made a loud report when they were fired off, and the noise of the ball was heard at the distance of 10 coss, or nearly 1445 yards," concludes from it "that the fact of cannon balls having been propelled by means of gunpowder in India as early as A.D. 1200, the epoch of the poet, appears to be established, although the use of artillery is not mentioned by any European writer before the fourteenth century." There is no reason to believe that this was the first, or even a very early instance of the use of such projectiles in the East; and it must therefore be considered highly probable that both the knowledge and the use of the explosive properties of compounds of nitre with charcoal and sulphur were of remote origin in a country which yields as a natural product, even to this day, so large a quantity of this important military mineral. Piobert, Napoleon Buonaparte, and other writers, have collected much information on the appearance and progress of artillery in Europe; but it is satisfactory to quote such examples from the work[1] of an English officer of artillery, so highly distinguished as Colonel Chesney, who has shed so much lustre on his profession by the intrepid zeal and persevering energy of his Euphrates expedition, and his great literary and scientific acquirements. "The Moors, according to Condé, used artillery against Zaragossa in 1118; and in 1132 a culverin of 4 lb. calibre, named Salamonica, was made. In 1157, when the Spaniards took Niebla, the Moors defended themselves by machines which threw darts and stones by means of fire; and in 1156 Abd'almumen, the Moorish king, captured Mohadia, a fortified city near Bona, from the Sicilians by the same means. In 1280 artillery was used against Cordova; and in 1306 or 1308 Ferdinand IV. took Gibraltar from the Moors by means of artillery. Ibn Nason ben Bia, of Grenada, mentions that guns were adopted from the Moors, and used in Spain in the twelfth century, and that balls of iron were thrown by means of fire in 1331. These, and other examples, render it almost certain that the use of gunpowder became first known in Europe through the Moorish conquests and warfare in Spain, although the true components of gunpowder were known to Friar Bacon, and were made generally known throughout Europe by Bartholdus Schwartz in 1320. Edward III. of England used 'crakeys of war' during his campaign against the Scots in 1327. In 1339 ten cannons were prepared for the siege of Cambray by the Chevalier Cardaillac. Quesnoy was defended successfully in 1340 by cannon which flung large iron bolts. In 1343 the Moorish garrison of Algesiras, besieged by Alphonsus XI. of Castile, used long mortars, or troughs of iron which threw among their enemies thunderbolts. In 1346, an iron gun, with a square bore capable of projecting a cubical iron shot of 11 lb. weight was constructed at Bruges. In 1346 Edward III. is said to have used artillery at the battle of Cressy; but this is very doubtful, as the application of guns to field operations appears to be of later date, and no notice of them at the subsequent battle of Poictiers can be traced. In 1347 Edward did, however, use artillery in the siege of Calais, as did the Prince of Wales in 1356 in reducing the Castle of Romozantin. In 1378 Richard II. employed 400 cannons, which fired day and night, in his unsuccessful attack on St Malo; but it is unnecessary to follow further the progress of this most important arm in the attack and defence of fortified places and positions. The French, in the latter portion of the fifteenth century replaced the old cumbrous bombards by brass guns with trunnions, and the heavy stone shot by metal balls; and as the results of these changes were rapid firing and an increased impetus of shot, artillery may then be said to have first become really effective. Though portable guns had been occasionally made, from the earlier half of the fourteenth century, and had been abundantly applied in the wars of the fifteenth, they do not appear to have been reduced to a perfect system of field artillery until the reigns of Charles VIII. and Louis XII., and in 1500 the latter monarch was able to move his artillery from Pisa to Rome, a distance of about 240 miles, in five days, and possessed light pieces which were sufficiently manageable to be taken rapidly from one point to another during a battle. When he recovered Genoa in 1507, he had 60 guns of large calibre for an army of about 20,000 men, and overcame the Venetians on the Adda in 1509 by means of his artillery. Francis I. adopted a lighter construction for field-guns, and had them drawn by the best description of horses." In the defeat of the Swiss at Marignan in 1515, "the French artillery played a new and distinguished part, not only by protecting the centre of the army from the charges of the Swiss phalanxes, and causing them excessive loss, but also by rapidly taking such positions from time to time during the battle as enabled the guns to play upon the flanks of the attacking columns." These extracts, which have been principally derived by Colonel Chesney from the celebrated work of the present French emperor, who, like his illustrious uncle, was an artillery officer, go far to prove that, though the French have no right to claim the invention or even the material improvement of the bastion system in fortification, which was manifestly the work of Italian engineers, they have great reason to claim the first establishment of an efficient field artillery. In 1631 the great Gustavus Adolphus was indebted in great part to his artillery for the victory of Leipzig; and some of his guns were of the remarkable description called cannons of boiled leather, which "consisted of a thin cylinder of beaten copper screwed into a brass breech, whose chamber was strengthened by four bands of iron; the tube itself being covered with layers of mastic, over which cords were rolled firmly round its whole length, and equalized by a layer of plaster, a coating of leather boiled and varnished completing the piece." The carriage and the piece were so light that two men were sufficient to draw and serve the gun, which, however, could bear only a small charge. In the battle of Lutzen, when this truly great warrior, for he was a Christian warrior, closed in death his short but brilliant career, the Swedish artillery was again remarkable for the ease with which it was manœuvred and shifted in position, whilst the less manageable cannon of the Imperialists were comparatively immovable. Colonel Chesney observes, in respect to these two great and glorious battles of the Swedes, that they prove that the artillery of Gustavus Adolphus, although still consisting of too many calibres, was admirably organized, embracing as it did limbers, and carrying cannister shot, and other kinds of ammunition, ready for action; and that this distinguished commander was the first who fully appreciated the importance of causing the artillery to act in concentrated masses. Frederick the Great of Prussia further improved upon the system by introducing pieces of ordnance sufficiently light to take part in the most rapid manœuvres; and since that time it has been admitted by most military men that guns intended to move with an army and take part in field operations, should be divided into two sections, namely: 1st, Guns sufficiently light to move with cavalry, and hence forming what is called in the British service Horse Artillery or *Cavalry Artillery;* 2d, Guns of larger calibre and greater weight than the former, to act with infantry, but still not too heavy to allow of considerable rapidity in all the changes of position which may be required on the field of battle. These constitute what are called field batteries.

[1] *Observations on Fire-Arms*, 1852.

The great improvement of the field batteries of the British army, and the superior horses attached to them on home service, have led many able English artillerists to imagine that the distinction between the field battery and the horse or flying battery is unnecessary, and that the former may be readily brought up in speed and efficiency, even when acting with cavalry, to the latter; but it is probable that this opinion has been formed more upon the results of field days on a favourable review ground, than on the experience of practice and movement on irregular ground such as must always be met with in actual war; and has been adopted without reference to the importance of securing for the field batteries, which must frequently be required to act as artillery of position in field works, the largest calibre compatible with a reasonable facility of movement. When this subject has been more fully considered and tested by experiments, more assimilated to the varied movements of war, it is believed that the value of the horse artillery will be better appreciated, and steps taken to render it still more effective by actual experience in war, for which the East Indian service, ever pregnant with events of war, is always open. The horse artillery is indeed too valuable a branch of this most important arm to be allowed to remain idle, or to be looked upon as a mere appendage to military shows. In like manner, such considerations would probably lead to the adoption of the 12-pounder on the other branch, rather than to any further attempts to increase the speed of field batteries, or to make them rival the horse artillery in rapidity of movement.

The difference between the rude guns of early times—formed with iron bars fitted together lengthwise, and secured by iron rings—and the well-proportioned iron or bronze guns of modern times, is assuredly very great; but there can be no doubt that artillery will yet be much more improved and its range increased so as to secure for it that superiority of range over the improved musket which it has hitherto possessed over the old musket.

By the adoption of artillery, the mode of application of propellent weapons has been changed, but not the principles. In war there has always been two forms of offensive action, namely, that carried on at a distance, and that conducted foot to foot or at close quarters; and the object of the first has always been to prepare for the second. The operation, therefore, of any means of offence is analogous to that of artillery. Archelaus[1] arranged his order of battle against the Roman general Sylla in the following manner:—In front he placed chariots armed with scythes, for the purpose of making an impression on his enemy's line; in the second, the Macedonian phalanx for attack; in the third, the armed auxiliaries as a reserve; and in a fourth the light troops, to be able to deploy and skirmish in every direction, whilst his numerous cavalry occupied both wings or flanks of the army. To meet this array, Sylla strengthened his position by wide trenches, defended by forts on his flanks, so as to prevent the enemy from outflanking and taking him in reverse with his numerous cavalry; and having thus restricted the attack within the limits of his centre, he arranged his foot in three lines, broken by intervals for the ready movement of the light troops and of the horse, which, being only a small body, was held back in readiness for a decisive charge at the right moment. Sylla further ordered a portion of his troops to drive palisades into the ground, between which the charge of the armed chariots could be awaited with little risk; and then, as the chariots advanced, they were received with loud shouts, and with showers of darts from the light troops, which threw them into such confusion that they turned and carried alarm into the ranks of the Macedonian phalanx, which beginning to yield, was for a moment supported by the cavalry of Archelaus, when the Roman cavalry suddenly charged, and won the victory. In this battle the armed chariots were intended to perform the office of artillery by first breaking the Roman line before the advance of the Macedonian phalanx; and in like manner, on the Roman side, the darts were propelled in the manner of artillery on the advancing troops. The comparatively small range of darts, arrows, or the bolts of cross-bows, limited the effect of their action so much, that though it was often very destructive when directed on an enemy who was obliged to retain his position, it was soon abated when an enemy was able to advance, or so reduced that its effect corresponded to that of the fire of light infantry. The case is very different with modern artillery, as their fire, commencing at a considerable distance, will continue to be destructive, even on an advancing force, for a considerable time. The objects, however, both of ancient and modern artillery are the same, namely, to make an impression on an enemy's line, and to disturb the stability of its masses before the last effort is made by a charge to overthrow it; and in like manner to break and paralyze an advancing column, so that its shock may be weakened or rendered comparatively harmless; and these objects ought therefore to be kept in view in the distribution and arrangement of artillery.

The value of any system of field artillery may be readily estimated by reference to its efficiency for producing the desired results which have been explained. For example, in the early period of British artillery, guns were allotted to each regiment or battalion as battalion guns; but though this arrangement was so far correct, as it rested on the principle that every body of troops capable of independent action should be accompanied in the field by artillery, it was erroneous when applied to large armies, as it spread the artillery through the line, and caused it to act either against artillery, producing a mere war of guns, or against infantry at so many points as to produce no decided effect at any. It is true, indeed, that such battalion artillery might have been separated, when necessary, from their battalions, and brigaded together; but it is manifest that the movements of an aggregate of so many separate elements which had not been previously trained to act together, must have been rude, uncertain, and very difficult of control: whilst the natural and simple mode of rectifying an arrangement so defective would have been the adoption of a combination of guns based upon some element or unit which represented the least number of guns deemed capable of acting with effect in co-operation with infantry.

To determine the unit or element of battery combination, it should be remembered that the principles of defence by artillery are the same, whether the guns act openly in the field, or covertly from behind a parapet, and that the object should be in either case to secure a cross, converging, or concentrated fire on the line or column of attack, or in front of the point to be attacked. A flanking fire is therefore as essential to an army in the field as it is in a fortress; in which latter case it may be justly said, that perfection depends even more on the efficiency and right arrangement of its active defences than on the solidity and permanence of the passive; as no walls of stone or of earth can be expected to stop an enterprising enemy, unless supported by a well-directed and steadily maintained fire. To obtain such a flanking and cross fire for the smallest number of troops likely to act independently, one gun on each flank or wing is the least possible number; and hence two guns may be deemed the elementary unit of battery combination; the term battery being applied primarily to a number of guns acting together, and secondarily, to the works of defence, or parapet, thrown up to cover them. In most of the armies

[1] *Strategematicon S. Julii Frontini.*

of the present day this principle has been acted upon; and the unit having been fixed (on an average) in relation to a body of 800 men (omitting cavalry, the action of which is propulsive or analogous to that of artillery), or of 1000 men, including cavalry, the strength of a simple field battery has been made some multiple of that unit; as, for example, exclusive of howitzers, in France, 4; Bavaria, 6: Sweden, 6; Spain, 6; Holland, 8 and 6; Wurtemberg, 6; Prussia, 6; Russia, 6; Austria, 6; or, taking howitzers into consideration, in France, 6; Bavaria, 8; Sweden, 8; Holland, 8; Wurtemberg, 8; Prussia, 8; Russia, 8; Austria, 8; two howitzers having been in each case apportioned to a battery; so that, when required to be subdivided for action on the flanks of the infantry to which it is attached, each half-battery may be provided with one howitzer. In the British artillery this latter principle has not been attended to; and though the combined battery consists of six pieces, 5 are guns, and 1 a howitzer, not therefore admitting of exact division of either. The duke of Wellington appears to have been sensible of this defect in principle, as he suggested the increase of the number to 8, that is, to 6 guns and 2 howitzers, which would have assimilated the British to the Prussian, Russian, and Austrian artillery, in respect to the strength of its field batteries; the number of howitzers being one-fourth of the whole, rather than one-third, as in the French, which appears excessive.

In conforming to the necessity of so arranging artillery as to ensure a flanking defence, either to the line of troops, or to the position exposed to attack, it must of course be kept in view that the effective range of field battery guns will limit the extent of the line or position to be thus defended; and, therefore, that in long lines as many batteries must be interposed between the flanks as will ensure to each section of the whole line a sufficient artillery defence; or else that there shall be a facility of bringing up rapidly the required guns to the flanks of the actual portion of the line exposed to attack, and at once concentrating a heavy fire upon the ground in front of it. These considerations, as well as the similar necessity of supporting the movements of an attacking column by the fire of artillery on the point of the line to be attacked, and the changes which it may be found expedient to make during a battle in respect to that point, have made it manifest that artillery, to be really useful in the field, must not be too heavy; and, in consequence, the guns of field batteries (properly so called) of all European nations are now comprised between the 6 and the 12-pounder, exclusive of the still lighter ordnance for mountain service. Marshal Marmont[1] observes,—"Field artillery is required to follow the troops in all their movements, and to arrive at any given point with promptitude, so as to crush an enemy. It should therefore be light, easily transported, and so handy as to be stopped by no impediment of ground. The 6-pounder, in use throughout Europe, appears to me sufficient; it was the calibre I adopted when at the head of the French artillery; and it was that with which the wars of the empire were waged. A calibre of eight has now been adopted; and though, without doubt, its superior weight has advantages, it has the great inconvenience of increasing by one-third the weight of ammunition and stores, and of requiring more powerful means of transport, which in a war it is difficult to provide." In addition, however, to these calibres, Marmont recommends the 12-pounder as necessary in silencing the fire of an enemy's field works, in arming such works, in battering down simple walls, or in defending the passage of rivers, and even suggests a small proportion of short 24-pounders intended to be fired with diminished charges. Such are the pieces which a general so experienced in war recommends for field artillery, and the objects he assigns to each are manifestly those which must be comprised within the scope of a well-considered establishment. The calibres he names are in English weights equivalent nearly to $6\frac{1}{2}$, $8\frac{5}{8}$, 13 lb.; so that, on an average, they correspond very closely with those adopted in the British service; but though there is much to say in support of this view of the subject, and specially in favour of the lighter calibre, as possessing such facility of movement, it is time to inquire what influence is likely to be exercised on field artillery in action by the improved musket of the present day. In considering this question, it is right to remember that, whilst it is the office of artillery to act against infantry, and to prepare the way by the disturbing effects of its fire for the ultimate shock or bayonet charge, so is it the office of tirailleurs or riflemen to act against artillery, and check or even paralyze its fire. Lieutenant-Colonel the Hon. A. Gordon, in his recent work addressed to the volunteers,[2] states that "the French have not yet adopted any of the new systems (except for trial in a few special corps), nor have they, from what I can learn, any intention of doing so;" and this caution, on the part of men so fully acquainted with military science, ought to be ascribed to the real cause, namely, a conviction, as Lieutenant-Colonel Gordon observes, that the ordinary soldier, from the skill of his commander in manœuvring, and the selection of positions, will not be exposed to an enemy's fire, or at least kept standing so exposed at a great distance; and that the full advantage of muskets or rifles, which are capable of shooting with accuracy up to a range of 800 yards, can be only looked for when they are placed in the hands of men of more than ordinary nerve, coolness, activity, and skill. Napoleon, who above all generals understood the importance of a right application of artillery in the field, and who in consequence employed his guns in masses so as to concentrate upon any one point an overwhelming discharge, was also fully sensible of the services to be derived from efficient tirailleurs or riflemen in checking the fire of artillery, and that more especially when the guns were assembled together in powerful batteries. He also knew well how to use riflemen occasionally as artillery, either by directing their fire against ordinary infantry at the point to be attacked, or as a means of protecting the movements of other troops; as, for example, in the campaign of 1807, when his first bridge over the Danube was constructed under the protection of his battalions of tirailleurs, who swept the island of Lobau with their fire.

During the campaigns of Napoleon and Wellington, the rifleman was armed with a weapon possessing only a very limited range and comparatively slow in loading; but had it been otherwise, and had he possessed the modern rifle musket, which unites rapidity and precision of fire with a long range, can it be doubted that some of the most brilliant movements even of that distinguished artillery officer General Senarmont would have been impossible. On the 29th January 1807, the corps d'armée of Marshal Augereau advanced on Eylau, and took up a position in rear of that town. Senarmont at first posted the artillery of the first division, consisting of eight 8-pounders, two 4-pounders, and two howitzers on an elevated knoll; but finding that, from this exposed situation, the battery became the mark of all the enemy's batteries, arranged as they were in a line concave towards the French, and was soon, therefore, greatly cut up, he determined to move forward to some flat ground in front on a lower level, whilst the artillery of the second division took up their first position in order to divide the attack of the enemy. These two batteries were in line, and swept the space between the two armies, so that the Russian infantry and cavalry, as they successively advanced to the charge, were mowed down by the fire of the 19 combined

[1] *Esprit des Institutions Militaires.*

[2] *Remarks on National Defence*, 1853.

guns. The nearest of these batteries was about 450 yards from the Russian line, and though then tolerably secure from all but the fire of artillery, what would have been its condition had the Russians possessed the modern musket, and been able to pick off every man and every horse from a distance of 600 or even 800 yards? Again, at the battle of Friedland, June 1807, the French had suffered so much from the fire of the Russian battery on the opposite bank of the Alle, that the troops began to waver, when Senarmont collected together 36 guns from several divisions and brought them up with great rapidity to an eminence about 450 yards from the enemy, and after a few discharges pushed on to another point at only 230 yards from the Russians, when the rapid and well-directed discharge of 36 guns soon silenced the small detached batteries of the Russians, and being then turned upon the closely-packed masses of the infantry, spread destruction and confusion amongst them. The successful issue of this battle is ascribed by General Marion, the biographer of Senarmont, to the admirable manner in which that officer handled the artillery. "It was due," he says, "to the admirable feat of arms of General Senarmont, and the artillery cannot cite one more glorious. Thirty-six pieces of artillery did what Ney and Dupont with more than 20,000 men had been unable to do, and what the three reserve divisions of Victor would probably not have done. Looking at the steady courage with which the Russians, when their retreat had been cut off, resisted the attacks of the triumphant army, it may be well assumed that victory would have been impossible to any other arm than artillery; but Senarmont advanced his guns and obtained the most brilliant success." In this case the artillery acted almost as an independent body, and bold and successful as the manœuvre was, it may be fairly stated that under present circumstances the repetition of such an act of daring would be attended with the utmost peril.

If the object were to bring into one general point of view the importance of the artillery arm, as illustrated by its achievements in modern wars, numerous examples might be brought forward from the annals of the British army, both in its European and Indian branches, as well as from the exploits of the French and other armies; but at present those cited will be sufficient to point out the peculiar circumstances under which artillery have acted with overwhelming effect, and to suggest the controlling influence which must henceforth be exercised over its movements under similar circumstances. Nor is positive experience wanting on the present state of the question, as the Prussian needle gun was actually in use during the recent contests of the Prussians and Danes; and according to an eye-witness (Lieutenant-Colonel Stevens, Royal Marine Artillery), was the instrument by which the Danish artillery was effectually kept in check even at the distance of 800 yards. Such considerations should impress upon the military authorities the necessity of directing their attention to the following points:—

1*st*, The employment of the largest calibre which is consistent with a due degree of celerity of motion.

2*d*, The propriety of having 6-pounder batteries for the horse or cavalry brigade, 9-pounder batteries for the ordinary infantry or moving brigade, and 12-pounder batteries for position and reserve.

3*d*, The attainment of perfection in the use of spherical case as applicable to ranges beyond the effective fire of the new rifled musket, and the more general use of this excellent projectile.

4*th*, The formation of howitzer batteries, so as to use the largest possible shell which can be attained without an inordinate increase of weight in the gun, and yet to retain a sufficiency of range.

5*th*, To cover the artillery when possible with light entrenchments, sufficiently thick to secure the men from musketry fire, and yet such as can be rapidly opened at the crest for the guns to fire over or through.

6*th*, The improvement of rockets, and the extension of their use as auxiliaries to guns.

7*th*, The combined operation of artillery and riflemen.

8*th*, The still further extension of the principles of ordinary field-work defence to the use of artillery, by a system of supporting or flanking batteries intended to scour the ground in front of those batteries which require to be advanced in order to produce a decided effect on an enemy's line. Such a service could only be done effectually by spherical case, and therefore might be confided to howitzers.

In point of general organization, it may without hesitation be assumed, that the British artillery stands in the first rank of excellence, and yet the improvements which have raised it to a state of such perfection are the work of the present age. At the commencement of the war in 1793, the various ordnance equipments, as well as the whole composition of this branch of our military service, were of the rudest kind, and on the worst organized and most defective plan. The inefficiency of the whole system, indeed, was palpably betrayed whenever a force was required to take the field. The guns being dispersed among the infantry, at the rate of two pieces to a battalion, it was impracticable to employ them for their legitimate purpose of concentrating a powerful fire of numerous guns on any important point. They were also horsed in single team, which needlessly both lengthened the column of march and diminished the power of draught. The drivers were on foot with long whips, as were also the gunners. The ammunition was packed in large rough deal boxes; the waggons which conveyed it were heavy and ill-constructed; and the whole equipment was so cumbrous, that it was impossible for the train to move out of a foot-pace, except for a very short distance; and if increased speed were attempted before the enemy, the men came into action breathless and unable to serve their guns.[1]

But before the commencement of the Peninsular war, that active and able officer, the late Major Spearman, had entirely re-organized this branch of the service; and it is to him that the country owes the present beautiful system of field artillery. The battalion guns were abolished, and the artillery was brigaded, distinct from the infantry and cavalry with which it served, in divisions of six pieces each; so that the fire of one or more of these powerful batteries could be readily concentrated on any given point. A body of military drivers was organized, while, by an ingenious contrivance of the shafts, the power of using single draught in narrow roads, or when any of the horses were disabled, was retained. The drivers were mounted on the near horses; and the gunners themselves, in the proportion of eight to each piece, were carried on the limbers and ammunition cars. The whole of the equipment was simplified and lightened to such a degree that the batteries could move at a gallop; the ammunition, packed in boxes on the limbers and cars, was always up with the guns; and the officers and men, being all mounted or conveyed on the carriages, were sure of being brought fresh into action. Finally, a system of manœuvres for artillery in the field was introduced, which gave order and precision to their own movements, and established uniformity between them and the troops of other arms.[2]

Such was the general condition in which the artillery was

[1] *British Gunner.*

[2] *Ibid.*

Field Artillery.

then placed, and it may be fairly stated that no pains have been spared by those subsequently in authority to improve its details and increase its efficiency. Of this arm the cavalry artillery branch is in the British service more especially a horse artillery, as so many of its men are carried on horseback; whereas, in the Austrian service, the men are carried on light spring waggons. The respective merits of these two systems require to be more fully investigated, and no prejudice in favour of our own system, which is certainly the more brilliant in appearance on a field-day, should be allowed to prevent its rejection, if found on comparison inferior. The British system involves the care of a larger number of horses both in the field and in camp, and hence greater trouble and anxiety to the men; the Austrian, the chance of having the locomotive power of the whole gun detachment crippled by the destruction or injury of a single waggon. In respect merely to comparative speed, it is probable that a light spring waggon would be fully able to keep pace with the guns, and to move over any ground practicable for them.

To secure the successful employment of an artillery force, it is necessary that the whole body should be carefully trained, and that the objects to be attended to should be fully understood. General Lewis has therefore exhibited the subjects of artillery in a very simple form,[1] which, with a slight modification, is here given:—

- *Personnel*
  - Horse artillery.
  - Rocket do.
  - Foot do.
    - Field.
    - Garrison.
  - Invalid gunners.
  - Master gunners.
- *Materiel*
  - Ordnance
    - Iron
      - Guns.
      - Howitzers.
      - Mortars.
      - Carronades.
    - Brass
      - Field guns.
      - Field howitzers.
      - Mortars.
    - Rocket
      - Field.
      - Heavy.
  - Carriages
    - Travelling
      - Field.
      - Siege.
    - Standing
      - Wood.
      - Iron.
  - Platforms
    - Ground
      - Wood.
      - Stone.
    - Traversing
      - Wood.
      - Iron.
  - Ammunition
    - Powder
    - Shot and shells.
    - Case or cannister, spherical case, grape.
  - Stores in general.
- Instruction
  - Academical for Officers
    - Theoretical
      - Mathematics.
      - Fortification.
      - History and Geography.
      - Plan Drawing.
      - Landscape Drawing.
      - Languages.
    - Practical
      - Drills—both Infantry and Artillery.
      - Sword Exercise.
      - Gun and Mortar practice.
      - Repository Course.
      - Laboratory Course.
      - Foundry, Proof, and Carriage Department Courses.
  - Elementary Tactics for Non-Commissioned Officers and Gunners.
    - Theoretical
      - A Course of Elementary Instruction in the Schools.
    - Practical
      - Infantry Drill, and other exercise of Arms.
      - Field Battery Exercise.
      - Gun, Mortar, Howitzer, and Rocket practice.
      - Repository Course.
      - Partially Laboratory Course.

FIELD ARTILLERY.

When an army is to take the field, several considerations must be attended to in apportioning the number and calibre of the batteries to accompany it; as, the face, features, and general nature, mountainous or otherwise, of the country which is to form the theatre of war,—the state of its roads, and the resources which it can supply for the means of transport,—the force and description of troops composing the army,—the nature of the war, whether offensive or defensive,—and, lastly, the intended plan of operations.[2]

In carrying on offensive operations in a champaign country, with good roads and facility of transport, the artillery should consist of 9-pound batteries, to which 12-pounders, and probably a few 18 or light 24 pounders should be added, to form on occasion batteries of position. There should likewise be one or more batteries of a lighter calibre, to accompany any corps of the army that may be destined by rapid marches to intercept the enemy's convoys or detachments.[3] In mountainous or deep hilly countries, the artillery should not be composed of heavier ordnance than the 6-pounder battery; but an exact topographical acquaintance with the nature of the country is absolutely necessary, and indeed affords the only satisfactory guide for judging of the most appropriate calibres to be employed. When an army is to

[1] *Aide Memoire to the Military Sciences.*

[2] *Traité Elémentaire d'Artillerie.*

[3] D'Antoni.

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remain on the defensive in a country where the roads are only tolerable, and the probability of being obliged to undertake long and rapid marches is not great, the artillery should be composed of a heavier description of batteries than would be proper to accompany an army acting offensively in the same country. But if this defensive system be carried on in a strong country, where the means of transport are attended with difficulty, and long and rapid marches may become indispensably necessary, the batteries must be so constituted as to adapt them to these several circumstances, otherwise the artillery will retard the army in its operations, instead of contributing to the attainment of the object in view.[1]

From considerations connected solely with the combined action of artillery and infantry, it has been deduced as a rule that a battery should consist of some multiple number of 2 guns, for example of 4, 6, or 8, and that howitzers should be combined with them also in pairs, making therefore a compound battery consist either of 4 guns and 2 howitzers as in France, or 6 guns and 2 howitzers as in Russia and most other European nations. The French battery has the great advantage of easy subdivision, as a half-battery would consist of 2 guns and 1 howitzer, and be therefore still complete in both natures of ordnance when called upon to act with the smallest independent force; and, at the same time, be in about due proportion to it. From the following historical examples of the relative proportions of artillery acting with various armies in different countries during the late war, it will be seen that experience has led to about the same proportions; and an officer, therefore, may, with the assistance of good topographical maps, form a tolerably accurate judgment on this important branch of military study.

The Austrian army, under the command of the archduke Charles in the campaign of Aspergne, Essling, and Wagram, consisted of about 75,000 men, to whom were attached 18 batteries of brigade, 13 of position, and 11 of horse-artillery; being nearly in the proportion of one piece of ordnance to 260 men.

The allied British and Portuguese army in the field in Spain, May 1813, consisted of 65,000 men and 102 pieces of artillery, including the reserve; being nearly in the proportion of one piece of ordnance to 622 men.

The grand French army under Napoleon for the invasion of Russia, not including the Austrian contingent, consisted of 400,000 infantry, 60,000 cavalry, and 1200 pieces of artillery; being one piece of ordnance to 383 men.

The French armies united on the Tormes in December 1812 amounted to 80,000 men and 200 pieces of artillery, being in the proportion of one gun to 400 men.

Napoleon in 1813 had 1400 pieces of artillery to 300,000 men, or one gun to 200 nearly. In 1815 his army consisted, as nearly as can be ascertained, by a comparison of several accounts of the campaign, of 130,000 infantry, 20,000 cavalry, and 300 pieces of artillery; being one piece of ordnance to 500 men.

The Prussian contingent of the grand French army for the invasion of Russia, under the command of General D'York, consisted of 20,000 men and 60 pieces of artillery; being nearly in the proportion of one piece of ordnance to 333 men.

Marshal Beresford, at the battle of Albuera, had 29,000 men and 32 pieces of artillery, or one gun to 900 men. His opponent Marshal Soult, in the same action, had 23,000 men and 40 pieces of artillery, or one gun to 575 men.

General L'Espinasse, who commanded the artillery of Buonaparte in Italy, supposes a division of an army to consist of 12,000 men, including a regiment of dragoons and another of hussars, to which he allots three batteries of horse and three of field artillery, each consisting of six pieces of ordnance. A battery of horse and another of field artillery are at all times to be up with the army; two batteries, similarly armed with the two in activity, are to remain with the park; and the remaining two, also appointed in like manner, should be in depôt in rear of the army. These proportions of artillery to infantry, L'Espinasse states, are precisely those adopted with the approbation of Buonaparte in the Italian campaigns.[2]

Positions and Movements of Field Artillery.

It has been pointed out that the principles on which the application of artillery should be regulated in the field, are the same as those which guide the engineer in the formation of his lines of intrenchments, his forts, or his fortresses. In fact the offensive action of artillery must be the same in its direction and objects, whether the guns are firing over a parapet, through an embrasure, or in the open field. The necessary exposure in the latter case may indeed render it expedient to rest satisfied with only a portion of the possible effect of the guns, so far as position is concerned, in order to gain for them greater security; but this does not invalidate the general principle.

The commanding officer of artillery, then, in order that he may choose proper positions for his field batteries, should be made acquainted with the effect intended to be produced, with the troops that are to be supported, and with the points to be attacked, that he may place his artillery so as to support, but not incommode the infantry, nor take up such situations with his guns as would be more advantageously occupied by the line; that he may not place his batteries too soon, nor in exposed situations; that he may cover his fronts and flanks by taking advantage of the ground; and that he may not venture too far out of the protection of the army, unless some very decided effect is to be obtained by so doing.

In a defensive position the guns of the largest calibre should be posted on those points from which the enemy can be discovered at the greatest distance, and from which the whole extent of his front may be seen. In an offensive position, the weakest points of the line, and those most distant from the enemy, must be strengthened by the largest calibres. Those heights on which the army, in advancing, may rest its flanks, must be occupied by guns, as also those from which the enemy may be fired upon obliquely.

Artillery should never be placed in such a situation that it can be taken by any enemy's battery obliquely, in flank, or in reverse, unless a position under these circumstances offers every prospect of producing a most decisive effect before the guns can be destroyed, or placed *hors de combat*. The most elevated positions are not the best for artillery; the greatest effects may be produced from a height of from 30 to 40 yards at the distance of 600, and from about 16 yards high at 200 yards distant. Those positions which are not likely to be shifted, but from whence an effect may be produced during the whole of an action, are to be preferred, and in such positions breastworks of two or three feet high should be thrown up to cover the carriages.

The guns must be so placed as to produce a cross-fire upon the enemy's position, and upon the ground over which he must pass to the attack. It may sometimes be necessary, in order to concentrate a cross-fire on one particular point, to subdivide the batteries, so that whilst the enemy's fire may be attracted to different objects, that of the opposing force is directed to a focus, such as the *débouché* of the enemy, the head of his advancing columns, or the ground in front of the weakest point in his own line. If the enemy's position is to be attacked, the fire of the attacking force must become direct in proportion as the troops advance, otherwise

[1] *British Gunner.*

[2] *Essai sur l'Artillerie*, par le Général L'Espinasse.

Field Artillery.

it will impede them; and when the fire can no longer be directed with safety on the point to be attacked, the guns must be directed on the collateral points.

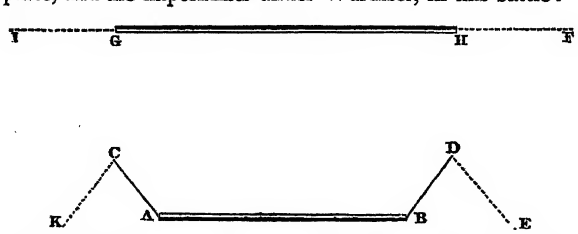
The guns should be placed as much as possible under cover. This is easily done upon heights, by keeping them so far back as that only the muzzles may be perceived over them. With proper attention, many situations may be found of which advantage may be taken for this purpose, such as banks, ditches, &c., everywhere to be met with. If an enemy's attack is expected, the guns must be posted so as to cannonade him with effect when he advances within 800 paces, and particularly in situations in which his march may be retarded by ditches, defiles, or other natural obstacles.

The position from whence the enemy is to be cannonaded should be kept concealed from him till the moment the batteries are to open. To effect this, the guns may until that time be placed in any other situation. Should there be any small elevations of earth in front of a defile through which the enemy may advance and be cannonaded, the guns must be kept under cover of them until he comes out and begins to form. The guns may also be masked by being covered by troops, particularly cavalry, until the enemy is within the range of case-shot. The covering party must then open right and left, and a brisk fire be kept up.

Artillery should very rarely be placed in front of a line of infantry, or distributed by batteries in the intervals. When the line is of great extent, it may become necessary to place a strong battery in the centre. This should be composed of the guns of the heaviest calibre; and it should be posted in the interval between the right and left wings of the army, by which means a double object is not offered to the enemy's fire. In general, an army in order of battle may be considered as a front of fortification, the infantry forming the curtain, and the lateral batteries the bastions, under the fire of which the troops may manœuvre freely, and advance with confidence to attack the enemy.

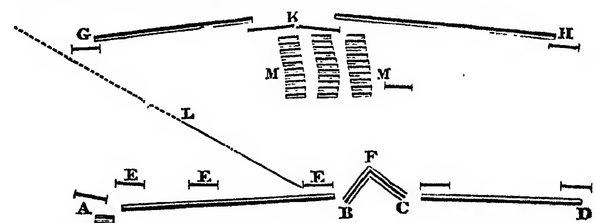
The two following examples will serve to illustrate the preceding remarks; and it may be observed in respect to the first, that had there not been heights in advance of the line of the French army which permitted the batteries to be arranged like flanks at the two ends of the line, the same effect might have been obtained by placing the guns *en echelon* along the space BE and AK of the following woodcut, and perpendicular to the lines BD and AC. This is indeed the system which the approved or official evolutions of artillery prescribe to be adopted.

Battle of Castiglione, 5th August 1796.—The following diagram shows the disposition of the French under Buonaparte, and the imperialists under Wurmser, in this battle:



A B the French army, G H the imperial army, A C a battery of 12 pieces of foot artillery, sustaining the left of the French on the heights in advance of Castiglione; B D a battery of 20 pieces of light artillery appuying on the right, which extended into the plain. The line of infantry A B being taken for the curtain, the batteries A C and B D may be considered as representing the faces of two bastions, thus forming a complete front, and crossing their fire before the curtain. The troops are consequently covered from attack, and the enemy fired upon obliquely. Wurmser having prolonged his front from G to I with the intention of outflanking the French, General L'Espinasse took some of the guns from C A, and placed them on the other face C K, until others could be drawn from the park for that purpose, thus forming a new battery destined to follow the enemy's movements. Another battery was likewise formed on the right, from D to E, in case Wurmser had prolonged his left from H to F.

Battle of Talavera, 27th and 28th July 1809.—At the commencement of the battle the British artillery were stationed, by batteries of 6 guns each, with the divisions of the army to which they were respectively attached; a temporary redoubt, unfinished, was thrown up at F, in which a battery of 3-pounders was posted; on the hill at A, the most commanding point of the position, two batteries were posted, one of heavy 6-pounders, the other of light sixes, to which two Spanish guns were afterwards added.



The French had a battery of 14 guns at K, the centre of their position; also one at each of the flanks G and H, independently of others which were brought up during the action. On the second day, when the columns at M advanced, supported by artillery, to attack the British right, which rested on the unfinished redoubt, the three batteries, E E E were formed on the oblique line L E, and thus took the advancing columns in flank, whilst the redoubt kept up a direct fire in their front.

It must here be observed, that whenever an oblique line is formed by artillery, as from L to E, it must be directed without the extremity of the enemy's flank, otherwise the guns will be exposed to his enfilading fire.

On considering the more general application of artillery, it is desirable to attend to the peculiarities in the mode of action of the several natures of ordnance, as exhibited in the following classified arrangement:—

ARTILLERY	Force produced by a sudden development of gaseous bodies in a state of high tension, by the almost momentary ignition of gunpowder.	The progressive velocity of the missiles, shot, musket-balls, fragments of shells, either entirely or mainly depending on the velocity derived from the projectile.	Guns, Carronades, Howitzers.
		Velocity of the fragments of the bursting shell, depending principally on the bursting powder of the shell itself.	Mortars.
	Force produced by a gradual development of gaseous bodies in a state of tension, by the progressive ignition of gunpowder.	... ...	Rockets.

An examination of this table shows that guns and howitzers should be used wherever it is desirable or necessary that the missile should possess a progressive movement, or a penetrating power in a progressive direction, as in firing at parapets, or in enfilading a long line of parapet; but that mortars should be used wherever it is required to act in a vertical direction, either for the destruction of a work which cannot be got at by a direct fire, or to assist the enfilade fire, when it is found, from the number of traverses, or the position of the ground on which the work stands, that the fire of the guns and howitzers has not been effectual. Keeping these points in view, we proceed to the next subject.

SIEGE ARTILLERY.

The first duty of the commanding officer of artillery, when it is intended to besiege a fortress, is to prepare an estimate of the quantity of ordnance and ammunition required for its reduction. To enable him to make this estimate with accuracy and precision, he should be master of certain data; that is to say, the commander of the forces, or general charged with the direction of the siege, should communicate to him a plan of the fortifications and environs of the place, accompanied by such profiles and remarks as may enable him, in conjunction with the commanding engineer, to ascertain which front or fronts are most assailable, with the advantages and disadvantages attending each attack, as well with respect to the works of the place as to the nature of the soil where the trenches must be opened, and the several heights and hollows of the vicinity.[1] He should also, if possible, be informed as to whether the place be amply supplied with artillery, ammunition, &c.; if the garrison be sufficiently numerous, and whether composed of veteran troops or raw levies; if the governor be in high estimation for his military talents; if the town be populous, and the inhabitants well affected to the garrison.[2] It will thus be easy to form a tolerably accurate opinion of the means of defence, and the resistance to be expected; for it is not to be presumed that any government would shut up a brave and numerous force in an ill-fortified and badly-provisioned place, at the risk of seeing such a garrison sacrificed after a short resistance.

But should it be impossible to procure information on these several points beforehand, particularly as to the strength of the garrison, the requisite proportion of ordnance and ammunition must be regulated on the general principles of attack. The officer intrusted to prepare the estimate must, therefore, endeavour to ascertain, according to the fundamental maxim of all besiegers, against which front or fronts the attack can be made with the least exposure and greatest expedition. He should examine whether the siege can be most advantageously carried on by regular approaches; by taking advantage of any defect in the situation which may enable him to break ground close to the works to be breached; or by battering them from a distance. By the aid of this investigation and the following general principles, the quantity of ordnance and ammunition required for the siege of a place may be ascertained with reasonable accuracy.

General Principles for the Attack of Fortified Places.

1. The number of batteries to be opened against the defences must depend upon the extent of the works to be embraced by the attack, *i.e.*, there must be a battery to enfilade every face that can in any way annoy or retard the besiegers in their approaches; but should this render it necessary to extend the parallels to an inconvenient distance from the actual direction of attack, the fire of the extreme faces of the enemy's works may be silenced by direct batteries.

2. The length of the epaulement of these batteries need not exceed the breadth of the terreplein of the works to be enfiladed, unless circumstances should render it necessary to place some of the guns in a situation to take the work in reverse. Each battery will only contain, therefore, five, or at most eight guns, to enfilade the face of the principal work; to which must be added two others to enfilade the branches of the opposite covered way.

3. The situation of the breaching batteries must be carefully determined, as, in a regular attack, they might sometimes interfere with the fire of the first or enfilading batteries. Should this be the case, the same artillery may be transferred from one battery to the other. It must be remembered, that though in the actual breaching batteries the guns should fire as nearly as possible perpendicular to the revetment to be battered down, it is by no means absolutely necessary to fire so nearly perpendicular when the object, as in the earlier direct batteries, is merely to ruin the earthen parapets. In this latter case, convenience may be attended to without scruple, and even some danger occasionally avoided by adopting a more oblique fire.

4. The supply of ordnance must be sufficiently liberal to enable the besiegers to keep up a fire constantly superior to that of the place. This supply therefore must be determined by the construction and extent of the fortifications of the place; taking care that, in addition to the guns required for enfilading batteries, there should be a preponderating number to act against every portion of the fortress possessed of the power of firing directly and effectively against the besiegers. The number of siege guns will therefore have a natural relation to the number adopted for defence.

5. As the *ricochet* firing may be interrupted while the sappers are completing the third parallel, a supply of royal and cœhorn mortars must be provided to harass the garrison from the second parallel, or demi-places of arms, during its cessation.[3]

Having thus ascertained the number of guns required, the following will be their calibres, and the proportions which the remaining ordnance should bear to them.

Guns—of the whole number required—suppose 60.

24-pounders.................................... $\frac{2}{3}$ or 40
12-pounders.................................... $\frac{1}{3}$ or 20

Howitzers—one for every four guns—in this case 15.

10-inch.. $\frac{1}{3}$ or 5
8-inch.. $\frac{2}{3}$ or 10

Mortars—in the proportion of one-twelfth more than the number of guns—in this case 65.

10-inch.. $\frac{2}{13}$ or 10
8-inch.. $\frac{3}{13}$ or 15
Royal.. $\frac{4}{13}$ or 20
Cœhorn .... $\frac{4}{14}$ or 20

In the above proportion of ordnance, it must be observed that the long 12-pounder is proposed instead of the 18-pounder formerly employed, as a gun of this description is conceived to be sufficiently powerful for annoyance and direct fire, to dismount the ememy's artillery, as well as for firing *en ricochet*. The diminished weight of ammunition attendant on the employment of the smaller calibre is an important advantage; but it is an arrangement which can only be admitted in cases where an adequate number of 24-pounders are provided. In all smaller equipments it would, therefore, be better that all the guns should be of the heavy calibre.[4]

The proportion of small mortars should in no case be less than that of the heavy mortars and howitzers, and this proportion ought to be increased in all equipments of less than thirty pieces of ordnance. Indeed, when sent at all, there should be at least twelve of them, to insure the necessary effect. In many cases a far greater number than is here

[1] *Traité Elémentaire d'Artillerie.* [2] *British Gunner.* [3] *Ibid.* [4] *Ibid.*

proposed could be advantageously used; but this must of course depend on the nature of the service on which they are likely to be employed. The royal and cœhorn mortars have, in the present instance, been taken in equal proportions, and it would be advisable to adhere to this arrangement in all the larger equipments, particularly when their calibres correspond with those of the guns; but in small equipments it would be more convenient to confine the arrangement to one calibre, in which case the royal mortar is the preferable, as it possesses the power of being used at a greater distance than the cœhorn. But it must at the same time be observed, that the latter, from its lightness and the small weight of its ammunition, is a more desirable implement for the more advanced parts of the attack.

The proportions per cent. of the ordnance here recommended, stand as follow:—

24-pounders	28·6	42·9	
12-pounders	14·3		
10-inch howitzers	3·6	10·7	
8-inch do.	7·1		
10-inch mortars	7·1	17·8	46·4
8-inch do.	10·7		
Royal	14·3	28·6	
Cœhorn	14·3		
	100·0		

A park of siege artillery in France consists of—

50 to 58 guns, either 24 or 16 pounders.
12 to 14 howitzers, of 8 inches.
10 to 14 mortars of heavy calibre.
6 to 8 do. of light calibre.

78 to 94 pieces:

Being, per cent.—

Guns—heavy	64·1	
Howitzers	15·4	
Mortars—heavy	12·8	20·5
Do. light	7·7	
	100·0	

giving a much larger proportion of guns and howitzers than that proposed by Captain Spearman.

In Austria the park is composed, per cent., of

Guns—24 and 16 pounders	40	47
Do. 12 pounders	7	
Howitzers	13	
Mortars—heavy	11	33
Do. light	22	
Do. stone	7	
	100	

proportions somewhat nearer to Captain Spearman's.

In Prussia the park is composed of—

Guns—24 and 18 pounders	48	58
Do. lighter calibre	10	
Howitzers	16	
Mortars—heavy	10	20
Do. light	10	
Do. stone	6	
	100	

proportions approaching more nearly to that of the French army. On the whole, it may be assumed that a satisfactory proportion might be deduced from all these, giving more guns than in Captain Spearman's, and more mortars than in the French arrangement, viz.:—

Guns	50	
Howitzers	15	
Mortars—heavy	15	35
Do. light	20	
	100	

The quantity and relative calibres of the ordnance being determined, the following will be the proportion and nature of ammunition:—

Gun ammunition.—Round shot,
24-pounder .... 1000 rounds per gun.
12-pounder .... 1200 rounds per gun.
Tier shot .... 50 rounds per gun.
Spherical case .... 100 rounds per gun.
Howitzer ammunition.—Shells,
10-inch .... 600 rounds per howitzer.
8-inch .... 300 rounds per howitzer.
Spherical case,
8-inch .... 300 rounds per howitzer.
Carcasses .... 10 rounds per howitzer.
Valenciennes composition,
10-inch ...... 100 proportions per howitzer.
Mortar ammunition.—Shells,
10-inch .... 600 per mortar.
8-inch .... 600 per mortar.
Pound shot,
10-inch... 50 rounds of 100 shot each per mortar.
Carcasses,
10-inch .... 10 per mortar.
8-inch .... 10 per mortar.
Valenciennes composition,
10-inch........ 100 proportions per mortar.

In the above proportion of ammunition there is an increase of 200 rounds in favour of the 12-pounders, as the facility of working these guns will, at an easy rate, afford the means of firing more rapidly than from 24-pounders. The proportion of one-half common shells and one-half spherical case should always be adhered to for the 8-inch howitzers.

Arrangement of Artillery at a Siege.

The first disposition of the artillery at a siege is to the different batteries raised near the first parallel. The object of the besieger in the construction of these batteries is, by a direct and enfilade fire, to dismount the artillery on the front attacked, destroy the embrasures, and harass the garrison in the several points of defence, so that they may be compelled to abandon them, or at least slacken their fire, and thereby enable the besieger to carry forward his approaches with greater expedition and less danger than he otherwise could do.[1] If these first batteries be favourably situated, the artillery may be continued in them during the whole of the siege, or until the besiegers arrive on the crest of the glacis. The garrison must be perpetually harassed along the whole front attacked, with shot and shells fired *en ricochet*. The batteries for this purpose are erected on the prolongations of the works to be enfiladed, from whence the defenders of the prolonged faces may be fired upon with great precision and effect.[2] It, however, frequently happens, from local and other circumstances, that the besiegers cannot avail themselves of the most advantagous situations for their first batteries. There are four situations from which the defences of a place may be destroyed, though not from all of them with equal facility. The best positions for the first batteries are those before described as perpendicular to the prolongations of the faces of the works to be enfiladed. If these positions cannot be attained, the next that present themselves are on those sides of the prolongations which take the faces in reverse, and under as small angles as possible. If the ground or other circumstances will not admit of either of these situations being occupied by enfilading batteries, the battery to destroy the fire of the face must be without its prolongation, so as to fire obliquely upon the outside of it: the fourth position in point of advantage is directly parallel to the face, or within that degree of obliquity which will allow a sufficient penetrative force to the shot or

[1] *Essai Générale de Fortification.*

[2] *British Gunner.*

Garrison Artillery.

shells. The guns must fire *en ricochet* from the first two positions, and from the last two with full charges.

The second batteries are generally placed on the glacis, within 15 or 18 feet of its crest; but if the foot of the revetment cannot be seen from this situation, they must be placed in the covered way, within 15 feet of the counterscarp.[1] The object of these second batteries being to effect practicable breaches in the works, they should be combined, two and two together, so that while one batters in breach, the other may play upon its defences. The breaching batteries shall commence by marking out as nearly as possible, by their fire, the extent of the breach intended to be made; first by striking out a horizontal line as near as possible to the bottom of the revetment; and next, by aiming at two others, perpendicular to and at the extremities of this first line. Then, by continuing to deepen these three cuts, and occasionally firing salvoes at the part to be brought down, the wall will in time give way in a mass. The guns must begin by firing as low as possible in the commencement of the operation, afterwards somewhat higher in the same manner as before, and so continue advancing gradually upwards till the breach is effected; for, should they fire too high at first, the rubbish would cover the lower part of the wall, retard the operation, and tend to render the breach impracticable. When the second batteries are placed on the glacis, or in the covered way, they must be sunk to such a depth that the terreplein of the one, or surface of the other, may coincide with the soles of their embrasures. They are in fact but an enlargement of the sap run for the lodgment on the glacis, or in the covered way, and should contain at least four guns each. If the space between the traverses will not admit of this number at the usual distances, the guns must be closed to distances of fifteen or twelve feet from each other.

The mortars are generally arranged at first in battery adjoining the first gun batteries, or upon the prolongations of the capitals of the works, in which situations they are certainly least exposed; and upon the establishment of the half parallels the howitzers are placed in battery, in their extremities, to enfilade the branches of the covered way. These batteries are in the most advantageous situations, if, while the one bombards the work that the besieger intends to assault and prevents the garrison from throwing up intrenchments within it, or at least retards their construction, the other directs its fire against the defences of the breach, so that the garrison may, from the continual shower of shells, &c., be compelled to abandon them, or, if they persist in remaining, be exposed to great loss. The small mortars are arranged in the third parallel, to annoy the besieged in the places of arms.

Mortars may also, as stated before, be advantageously placed opposite the prolongation of a face, on the same principle as an enfilading gun battery; and in this case they may be arranged one behind the other, being separated by traverses or epaulements.

In the establishment of all these batteries, the great object is to make such an arrangement of them, that they may not mask the fire of each other more than is unavoidable, and particularly that of the first or *ricochet* batteries. The aggravation of this inconvenience may very well be prevented till the establishment of the attack on the crest of the glacis, when it becomes in some degree unavoidable: however, even the operations of the glacis may be so arranged as not to mask the fire of the *ricochet* batteries, until the breaching batteries are in a state of great forwardness.

GARRISON ARTILLERY.

The proportion of ordnance, ammunition, and stores required for the defence of a fortified place depends not only on the particular situation of each individual fortress, and its relations with the surrounding country; the system according to which it is fortified, and the species of attack it may be possible to open against it; but likewise on innumerable minor circumstances, each of which may exert an important influence on the defence. If, for example, one or more of the fronts of a place be covered by an inundation, a marsh, or by any other impassable obstacle, it will manifestly require a much smaller proportion of artillery for its defence than if it were equally accessible on every front. On the contrary, a maritime fortress, which is susceptible of attack both by sea and land, will require a larger proportion of ordnance supplies than if it were assailable from only one of these points.[2]

It will be seen, therefore, from the above remarks and examples, how impossible it is to lay down any general rules upon this important subject. The only satisfactory guide which an officer charged with the nice and responsible trust of arming a fortified place can with security follow, is to examine attentively all parts of the works and of the surrounding country, and then to weigh every other circumstance that can in any way influence the defence. He should consider which of its fronts are most vulnerable, and what measures are best adapted for their security. To effect this with accuracy and expedition, he should, after a few days passed in reconnoitring and studying his position, devote his attention to the preparation of a sketch and profiles of the works and neighbouring country, as far at least as a mile in every direction, and upon a scale adapted to the features of the ground.

With this map and profiles before him, he should recur to those fundamental principles upon which every good attack and defence are based. He should not only be thoroughly acquainted with his own particular branch of the service in all its details, but capable of judging to the fullest extent of all operations in which the other troops of the garrison can bear their part; so that every supply may be adequate to its particular purpose, without deficiency on the one hand or superfluity on the other. Thus two extremes, equally prejudicial, will be avoided; the one, of making a provision insufficient for the defence which the fortress is capable of sustaining; the other, of providing such a quantity of supplies, that, on its capitulation, which, according to the natural order of things, must sooner or later happen, if it be not relieved, a complete arsenal would fall into the enemy's hands.[3]

These observations being held in mind, the following general maxims will be found of essential assistance.

General Maxims for arming Fortified Places.

1. The proportion of ordnance, ammunition, and stores should never exceed the quantity absolutely necessary to a brave and resolute defence.

2. Those fronts which are considered susceptible of attack should be completely armed, and the remaining fronts armed only in part.

3. There should be, for each of the faces of the bastions of such fronts as are deemed liable to attack, five or six pieces of ordnance; for each of the flanks of these bastions four pieces; and for the faces of the ravelin from five to seven pieces of ordnance. When there are lunettes, four pieces should be reckoned for each, and from two to three for each of the places of arms of the covered way. Supposing, therefore, one front to be completely armed, the following proportion of ordnance will be required

The faces of the two bastions	from 10 to 12
two interior flanks	from 6 to 8
faces of the ravelin	from 5 to 7
five places of arms	from 10 to 15

[1] *Traite d'Artillerie*, par D'Antoni; *British Gunner*.

[2] *British Gunner*.

[3] *Traité Elémentaire d'Artillerie.*

Garrison Artillery.

making a total for one front of from 33 to 42 pieces of ordnance.

4. In case of the place being liable to attack on two consecutive fronts, the above proportion should be augmented one half; and if on two detached fronts, it should be doubled. The remaining fronts should each be provided with such a proportion of their full armaments as will secure them from insult. It will appear from the above maxims, which are deduced from the best authorities on the subject, that a hexagon, having only one front exposed to attack, requires an armament of from 58 to 68 pieces of ordnance for its defence; and that for more extensive places, from six to eight, or at most ten pieces of ordnance, should be added for each additional front.[1]

The next point to be considered is the proportion which the several kinds of ordnance, and their relative calibres, should bear to each other; and here it must be remembered that the higher rates are not the only descriptions capable of being employed to advantage in the defence of a place. There are many cases in which medium guns can oppose equal resistance with the heavier calibres, and they possess the very important advantage of affording greater facility in manœuvring and transporting them from one situation to another; an operation of considerable difficulty with the higher natures of ordnance at all times, but particularly during a siege. They also consume less ammunition, and enable the besieged to keep up a more determined and incessant fire.[2]

The following are the proportions of the several kinds and calibres usually adhered to in ordinary cases.

Guns—in the proportion of two-thirds of the whole armament—suppose 60.

24-pounders	$\frac{1}{10}$ or 6
18-pounders	$\frac{2}{10}$ or 12
12-pounders	$\frac{3}{10}$ or 18
9-pounders or 6-pounders	$\frac{4}{10}$ or 24

Howitzers—one for every five guns—in this case 14.

10-inch	$\frac{1}{2}$ or 7
8-inch	$\frac{1}{2}$ or 7

Mortars—in about the same proportion as the howitzers—in this case 16.

10-inch	$\frac{1}{2}$ or 8
8-inch	$\frac{1}{2}$ or 8

The above distribution of guns, howitzers, and mortars, applies equally to all armaments of not less than 60 pieces of ordnance; and such an armament should therefore consist of 40 guns, 8 howitzers, and 12 mortars. The proportions of the several calibres of each kind, except those for the guns, are calculated on a basis of not less than 90 pieces of ordnance; and in all smaller armaments it would be advisable to confine the arrangement to two calibres of each kind only.

The preceding estimate of 68 pieces of ordnance for a hexagon must be taken as the least possible number, as it implies a very partial arming of the fronts not included in the scheme of attack, and a defence limited to a single front. To bring this up to a sufficient standard on the principles of estimate adopted, the following calculation may be given.

Faces of the centre bastion of the attack	12
Nearest faces of collateral bastions	12
Two flanks opposed to centre bastion	8
Two flanks of centre bastion	4
Adjacent faces of two adjacent ravelins	8
Remote faces of do.	4
Four adjacent places of arms	12
Two remote do.	8
	68
Armament of remote halves of two adjacent bastions	10
Armament of three other bastions at 10 pieces of ordnance for each bastion	30
	40

Colonel Timmermans gives 62 guns and howitzers, and 42 mortars, or 104 in all; besides some few stone mortars; and the Fortification Course of the Royal Military Academy 130, namely, 65 heavy guns, 13 howitzers, 39 mortars, and 13 field guns. If then the same proportion be adopted on the total number of 110 for a hexagon, the number of heavy guns will be 55, of howitzers 11, of mortars 33, and of field guns 11, which appears a very reasonable estimate for ordinary circumstances. In carrying it into effect, the number of field guns should, of course, be adopted which corresponds to the ordinary arrangements of field batteries; as, for example, 12; being two batteries of the present establishment, or $1\frac{1}{2}$ of that proposed.

In respect to the calibre of guns used in the defence of fortresses, the remarks of Colonel Timmermans deserve especial attention. He observes,

1*st*, That the superiority of attack over defence is in great measure due to the improvement of the siege artillery and operations, without a corresponding improvement in the defence, and hence that an improvement in the artillery of a fortress should tend to restore the equilibrium.

2*d*, That as the besieger is limited by the difficulty of transport to the use of guns of moderate calibre, the besieged should adopt guns of a more powerful calibre, so as to commence an effective contest with the besieger even at the earliest stage of the siege.

These remarks are just, and it would seem assuredly desirable to establish a superiority of calibre in the guns of defence whenever it is possible so to do. The present established table of ordnance exhibits the 8-inch shell gun 8 feet long, and weight 52 cwt; the 32-pounder 9 feet 6 inches long, and weight 56 cwt.; and the short 32-pounder 6 feet long, and weight 25 cwt.; which seem peculiarly fitted for the armament of fortresses, and are not so greatly different even in weight from the 24-pounder, which weighs 50 cwt., as to render their use difficult. Mortars also should be freely used in the collateral bastions, their fire being directed not against the battery nearly opposite to them, but against the battery opposite the corresponding bastion on the other side, so as to fall as nearly as possible in the direction of the parapet. Spherical case should also be freely used as a most effective missile. It may be added also as an argument in favour of heavy ordnance, that when the fortress has fallen, the guns will not be suitable for transport in the field.

The following will be the proportion and nature of ammunition for each species of ordnance.

Gun ammunition.—Round shot,

24-pounder	600 rounds per gun.
18-pounder	760 rounds per gun.
12-pounder	800 rounds per gun.
9-pounder or 6-pounder	1000 rounds per gun.

Case shot,

24-pounder	40 rounds per gun.
18-pounder	50 rounds per gun.
12-pounder	80 rounds per gun.
9-pounder or 6-pounder	100 rounds per gun.

Spherical case,

24-pounder	50 rounds per gun.
18-pounder	80 rounds per gun.
12-pounder	100 rounds per gun.
9-pounder or 6-pounder	150 rounds per gun.

Howitzer ammunition.—Shells,

10-inch	400 rounds per howitzer.
8-inch	600 rounds per howitzer.

[1] *Manuel de l'Artilleur; Traité d'Artillerie*, par D'Antoni

[2] *British Gunner.*

Garrison Artillery.

Case shot,
10-inch .... 100 rounds per howitzer.
8-inch .... 250 rounds per howitzer.
Spherical case,
8-inch .... 500 rounds per howitzer.
Light balls and carcasses,
8-inch .... 20 rounds of each per howitzer.

Mortar ammunition.—Shells,
10-inch .... 500 rounds per mortar.
8-inch .... 650 rounds per mortar.
Pound shot,
10-inch .... 500 rounds per mortar.
8-inch .... 600 rounds per mortar.
Each round of pound shot consists of 100 shot for the 10-inch, and of 80 for the 8-inch mortar.
Light balls .... 15 per mortar.

The above proportion of ordnance and ammunition for the defence of a fortified place is exclusive of one or more field batteries, which every place should contain, according to its extent, and which should be provided with a double proportion of ammunition: and it is only necessary to alter the calibre from 24 to 32, to reconcile it to the views previously expressed of the advantage of heavier ordnance.

This estimate and arrangement is founded upon the supposition that the place is unprovided with casemated batteries, the armament for which must of course form a separate estimate, calculated, however, upon the same principles as the above.

Arrangement of the Artillery during a Siege.

The instant it is ascertained that the enemy's troops are in motion towards the place,—presuming that it is amply supplied with provisions, ammunition, and stores, and that every precaution has been taken to collect from the vicinity what might fall into the enemy's hands,—the barbette batteries must be established in the flanked angles of the bastions and ravelins, and a proportion of the light guns and howitzers must be placed in the outworks and covered way. Should the body of the place have cavaliers, the heaviest guns should be mounted on them. The following arrangement is usually made for the reception of the investing corps, when it is not known from what point they may advance to commence operations.

There should be three guns mounted on the barbette of each bastion—one 24 and two 18-pounders, and three 9-pounders on the barbette of each of the ravelins. In the salient places of arms of the bastions, one 24-pounder howitzer, and in those of the ravelins two 6-pounders. The heavy mortars should be placed one in each bastion, and the remainder of the ordnance in reserve behind the curtains, ready to move on whichever side it may be required. As it is always very desirable to have as few calibres as possible, the 9-pounders might be advantageously replaced in all cases either by 12-pounders or by 6-pounders, according to the special circumstances; and the armament consist in general of the 8-inch shell gun, long 32, short 32, 12 feet and 6 feet, besides the field batteries.

By this arrangement the whole of the barbette guns, and of the guns and howitzers in the outworks and covered way, will be in readiness to act in any direction, till it is known on which side the enemy has determined to direct his attack, and, with the addition of the reserve, will enable the besieged to open a fire of thirty-five pieces of ordnance on the enemy, the very first night he begins to work upon the trenches. In the first moments of the investment, however, the artillery of the place should not endeavour, by a useless expenditure of ammunition, to disturb the besiegers in their operations; it is only when they are making permanent dispositions for their establishment that the fire of the place should be opened upon them. It is nevertheless necessary that some guns should be loaded with reduced charges to protect the retreat of the advanced posts, and mislead the enemy as to their range. This is also the moment, if the garrison be numerous, and composed of good troops, to annoy the besiegers by sorties on different points of the line of contravallation, and to retard the works necessary for establishing their communications; care must however be taken not to purchase this advantage by a loss of men and artillery, which would cripple the means of defence.

Coast Defences.

The day succeeding the night on which the trenches are opened, and the front of attack determined, a new disposition of the artillery of the place must be made as follows:—

The 24 and 18-pounders must be removed to the front attacked, and the other batteries, if necessary, supplied with 12-pounders. The barbettes of the bastions on this front must have each five guns, three 24 and two 18-pounders, and the remaining 18-pounders arranged behind the curtains,—two towards each of the extremities of the front curtain, and two at the farthest extremity of each of the collateral curtains. The howitzers in reserve should be placed two in each of the salient angles of the covered way of the bastions of this front, and two in each of those of the collateral bastions, which, with those already there, must fire *en ricochet* down the prolongations of the capitals. There should also be three 6-pounders in the salient place of arms of the ravelin of the front attacked, and three in each of those of the two collateral ravelins; these guns should fire over the palisading; and, lastly, there should be five 9-pounders on the barbette of the front ravelin. This arrangement will bring fifty-two guns and howitzers and four mortars to fire on the approaches after the first night. This, with a few variations, will be the disposition of the artillery of the place till the besiegers' first batteries are ready to open. The instant they begin to work upon these batteries, the whole fire of the place must be concentrated on them, and the mortars which had previously fired at low angles must now fire with greater elevation, but at all times sparingly.

As soon as the enemy's batteries are fairly established, the guns *en barbette* must be covered by merlons, and the embrasures occasionally masked. While this work is carrying on, the situations of the guns should be changed, and new directions given to them; as by frequently practising this manœuvre, the enemy will also be obliged to change his dispositions of attack, and time will thereby be gained by the besieged. As the enemy approaches towards the second parallel, the fire of the place must be spread over all parts of his line of operations; and with a view of contributing to this object, royal and cœhorn mortars should be disposed in the places of arms and branches of the covered-way. When the approaches are carried on from the second parallel, and the enemy is about to establish the demi-places of arms, the fire of the place must be concentrated on the *débouchés* from the parallel, and multiplied with all possible activity.

In proportion as the besieger pushes forward his approaches to the third parallel, the artillery must be withdrawn from the covered way to the ravelins, or to the ditch, if dry, or to any other favourable situation, and by degrees, as they advance, to the body of the place. During this period of the siege the embrasures must be prepared in the flanks, in the curtain which joins them, and in those parts of the faces of the bastions which command the ditch of the front ravelin. All these embrasures must be ready to open, and the heavy artillery mounted in them, the moment the enemy attempts to form a lodgment on the glacis. We have now arrived at the crisis of the siege, and every effort should be made to take advantage of this favourable moment, when the enemy, by his own works, must mask his former batteries, and before he is able to open his new ones.

COAST DEFENCES.

In a preceding paragraph, the opinion of Colonel Tim-

mermans of the Belgian artillery has been quoted in favour of the use of ordnance of high calibre in the defence of fortresses, and that of Marshal Marmont might be quoted to the same effect. "I come now," he observes, "to the artillery of Paixhaus. To fulfil their object, heavy guns should have a great range, and their missiles a great momentum. Hitherto this momentum has been obtained by the use of a moderate mass projected with a great velocity, on account of the difficulty of moving heavy ordnance; but though this reason is unanswerable in a siege where the guns must be moved in a limited time, and often under circumstances of great difficulty, it does not apply to the armament of ships, of fortresses, or of coast defences; in all of which cases such heavy artillery must possess immense advantages." In respect to coast defences the force of this reasoning has been fully admitted, as the effect even of a 32-pounder shot is small in comparison with that of an 8-inch hollow shot which weighs 56 pounds, and makes a fearful rent in a ship's side, which it would be difficult to stop up or repair.

The armament, therefore, for coast batteries, forts, or towers, includes guns of the highest calibres, viz.:—

1. 68-pounder for sweeping channels of more than ordinary length, so as to bring the ship within range as soon as possible.

2. 10-inch shell gun, to defend a point of very great importance, where a more than usually heavy fire is required.

3. 8-inch shell gun and 32-pounder of 56 cwt. as the general armament in the proportion of one shell gun to two 32-pounders. Both these guns can be used for setting fire to shipping, the one by shells and the other by red-hot shot, and therefore fulfil most of the conditions required for coast-battery guns. Lighter guns of similar calibre may be used for very short ranges, but it should always be borne in mind that as the efficiency of defence, since the application of steam as a motive power in ships, rests on the destructive effects of a few shots, and not on the repeated shocks of many, guns of a large calibre ought to have almost an exclusive preference, both from the superior precision and superior destructiveness of their fire. The 24-pounder has still been retained on the Ordnance Lists for protecting shallow beaches; but even in this case the short 32-pounder would be preferable, and the introduction of another calibre might be avoided.

EXERCISE OF ARTILLERY.

The several exercises are divided into three classes, as follows:—

1. Exercise of field artillery.
2. Exercise of garrison or siege artillery.
3. Exercise of the various machines employed in the manœuvres of garrison or siege artillery.

1. *Exercise of Field Artillery.*

The complement of men for the service of each gun or howitzer is, one non-commissioned officer and eight gunners.

Numbering and Telling off the Detachments.

The several detachments being arranged right in front, are numbered and told off by their respective non-commissioned officers in the following manner:—

The non-commissioned officer is invariably No. 1, and is responsible for the proper execution of the duties of the other numbers of his detachment. The right-hand man of the rear rank is named No. 2; his front-rank man No. 3; the second man from the right of the rear rank No. 4; and his front-rank man No. 5; and so on in succession from the right of the rear to the left of the front rank, till the numbering of the whole detachment is completed.

Formation in Order of March or for Exercise.

When detachments are formed in the order of march, or for the purpose of exercise, the even numbers are almost invariably on the right or off-side of the gun, and the odd numbers on the left or near side.

Positions of the several Numbers in Action.

No. 1 is on the left of the handspike; No. 2 outside the right wheel, in line with the muzzle; No. 3 outside the left wheel, and also in line with the muzzle; No. 4 clear of the right wheel, covering No. 2, and in line with the breech; No. 5 clear of the left wheel, covering No. 3, and also in line with the breech; No. 6 five yards in rear of and covering the left wheel; No. 7 in rear of the limber; No. 8 ten yards in rear of the gun, in line with the heads of the leading horses of the limber; and No. 9 attends the ammunition-waggon.

Duties of the several Numbers.

No. 1 points and commands; No. 2 sponges; No. 3 loads; No. 4 serves the vent and primes; No. 5 fires; No. 6 serves No. 3 with ammunition; No. 7 supplies No. 6 with ammunition, and, when firing shells, fixes the fuses; No. 8 assists No. 7, and occasionally relieves No. 2, or, when attached to $5\frac{1}{2}$ inch or 24-pounder howitzers, provides No. 3 with shells; No. 9 assists in preparing ammunition.

Limbering up, or Retiring from Action.

This manœuvre may be performed, according to circumstances, to the front, rear, right, or left. In limbering up to the front, the limber drives up to the right of the gun. No. 2 instantly passes his sponge over the axletree to No. 4, who straps on the sponge head; No. 2 and No. 3 go round to the trail; No. 4 and No. 5 man the wheels, assisted by No. 7 and No. 8 with heavy guns. The right wheel is run back, the left forward, and No. 1 and No. 6 throw the trail round in the opposite direction to that in which the limber drives up. The instant the trail is round, No. 1 unships his handspike, and No. 5 straps it on; No. 2 buckles on the rammer-head of his sponge, and the whole fall in close to the wheels. No. 6, No. 4, and No. 2 on one side, No. 5, No. 3, and No. 1 on the other; No. 7 attends the limber, and No. 8 moves up to his place. On the limber coming up square to the front, No. 1 orders, "halt, limber up," upon which No. 4 and No. 5 man the wheels, No. 2, No. 3, and No. 6, lift the trail and place it on the pintail; No. 1 then puts in the key, and the detachment mount, or fall into the order of march. The duties are precisely the same in limbering up to the rear, right, or left, except that in limbering up to the right or left, the trail and limber both go to the right or left; and in limbering up to the rear, the limber drives up rather to the right of the trail, which is not thrown round, and then reverses to the left.

Unlimbering or coming into Action.

This is precisely the reverse of the preceding manœuvre. No. 1 unkeys the pintail, No. 2 and No. 3 raise the trail, and when it is clear No. 1 gives the word, "Drive on;" upon which the limber goes off to the left about, and the trail is thrown to the right about, the other numbers assisting as they arrive, the same as in limbering up, No. 6 at the trail with heavy guns, and No. 4 and No. 5 at the wheels. As soon as the trail is down, No. 5 unbuckles the handspike, and No. 1 ships it; No. 2 unstraps the rammer-head and goes to his place; No. 4 unstraps the sponge, and passes it over to No. 2. When the limber is sufficiently to the rear, it reverses to its left, and halts ten yards in rear of and covering its gun. The ammunition-waggon also reverses to its left, goes off in front of the limber, and again reversing, to its left, halts one horse's length in rear of the gun-limber. No. 1 is responsible for the correct dressing of his gun when it comes into action; and for this purpose, immediately after the trail is in its proper direction he should place himself in line with

Exercises. the axle-tree of the gun upon which the formation is made, and dress his own gun with it. This position will enable him to see, not only that his gun is in its true *alignement*, but also that it is square to the front.

2. *Exercise of Garrison or Siege Artillery.*

This second branch of the exercises relates to the manner of working and serving guns, howitzers, carronades, and mortars, on batteries. The complement of men for the service of garrison or battery guns is, for the 42-pounder and 32-pounder, one non-commissioned officer and six gunners each; for the 24-pounder, one non-commissioned officer and five gunners; for the 18-pounder, one non-commissioned officer and four gunners; and for the 12-pounder and 9-pounder, one non-commissioned officer and three gunners each. The complement of men, duties, &c., are precisely the same for howitzers and carronades as the above for guns. The 13-inch mortar requires one non-commissioned officer and five gunners; the 10-inch mortar one non-commissioned officer and four gunners; the 8-inch mortar one non-commissioned officer and three gunners; and the royal and cœhorn mortars one non-commissioned officer and two gunners each.

All calculations for the daily service of guns on batteries, whether in garrison or at a siege, should be made in three proportions and at three reliefs.

Numbering, Telling off the Detachments, an dFormation for Exercise.

The same in every respect as for field artillery.

Positions and Duties of the Numbers.

No. 1, directly in rear of the gun, points, commands, and assists to run the gun up; No. 2, on the right of and in line with the muzzle, sponges, runs up, and elevates; No. 3, on the left of the muzzle, and also in line with it, loads, runs up, and elevates; No. 4, on the right of the gun, clear of the track, and in line with the breech, serves the vent, primes, runs up, and traverses; No. 5, in the same relative position on the left of the gun, fires, runs up, and traverses; the remaining numbers on the right and left of the embrasure, with their backs to the merlons. No. 6 serves No. 3 with ammunition, and runs up; No. 7 assists to run up. The whole of the numbers, when not immediately employed in working the gun, should range themselves in order under cover of the parapet.

In serving mortars, No. 1 is directly in rear of the mortar, and points, commands, and serves the vent; No. 2, on the right of and in line with the front of the bed, sponges, runs up, and traverses; No. 3, in the same relative position on the left of the bed, loads, runs up, and traverses; No. 4, on the right of the mortar, covering No. 2, and in line with the vent, runs up, elevates, supplies shells, primes, and traverses; No. 5, in the same relative position on the left of the mortar, runs up, supplies shells, elevates, traverses, and fires; No. 6, at the magazine, serves ammunition. No. 2 puts the shells into the 8-inch royal and cœhorn mortars, and in putting them into the 13 and 10-inch mortars is assisted by No. 3.

3. *Exercise of the various Machines employed in the Manœuvres of Heavy Artillery.*

The method of numbering, telling off, &c., is the same in every respect for this branch of the exercises as for the two preceding, except that, in the exercise of the devil-carriage, the odd numbers are posted on the right side, and the even numbers on the left.

Exercise of the Triangle Gyn.

The complement of men for a triangle gyn is usually one non-commissioned officer and ten gunners. The following are the duties in working or carrying the gyn:

Left side.	*Right side.*
No. 3 carries at the foot of the left cheek, works the left-hand lever, keys and unkeys the left-hand capsquare of the gun-carriage, and assists to run the carriage up or back.	No. 2 carries at the foot of the right cheek, works the right-hand lever, keys and unkeys the right-hand capsquare of the gun-carriage, and assists to run the carriage up or back.
No. 5 carries at the top of the left cheek, works the left centre lever, and assists to run the carriage up or back.	No. 4 carries at the top of the right cheek, works the right centre lever, and assists to run the carriage up or back,
No. 7 carries the levers and handspikes, assists No. 6 in passing the fall round the windlass, and holds on next to him.	No. 6 carries the windlass. passes the fall round it, holds on, makes it fast, and eases off and lowers the gun.
No. 9 carries at the top of the pry-pole with the slings, fid, trucks, &c., holds on the fall behind No. 8, and coils it up as it comes off.	No. 8 carries at the foot of the pry-pole with the slings, fid, trucks, &c., and holds on next to No. 7.
No. 11 Assists in carrying the blocks and fall, reeves and unreeves the triple block, assists in slinging the gun, and steadies it at the muzzle.	No. 10 assists in carrying the blocks and fall, reeves and unreeves the double block, assists in slinging the gun, and steadies it at the cascable.

Exercise of Bell's Gyn.

This is a light gyn calculated to raise about 30 cwt. When greater weights are required to be raised, the Gibraltar Gyn is used, which is calculated to raise a weight of 50 cwt. with perfect safety. The duties of the Gibraltar Gyn are nearly identical with those of Bell's Gyn, which it has now replaced in the service. The complement of men for working it is one non-commissioned officer and six gunners.

Left side.	*Right side.*
No. 3 runs the carriage up or back, assists No. 6 in slinging the gun, turns the winch, assisted by No. 5, or makes fast and hauls upon the rope which is passed round the handles of the winch.	No. 2 runs the carriage up or back, assists No. 7 in slinging the gun, turns the winch assisted by No. 4, or holds on upon the rope and makes it fast, the same as No. 3.
No. 5 runs the carriage up or back, and assists No. 3 at the winch.	No. 4 performs similar duties to No. 5 on his own side.
No. 7 slings and unslings the gun at the chace, assisted by No. 2, and steadies at the muzzle.	No. 6 slings and unslings the gun at the first reinforce, assisted by No. 3, places the bed and quoin, and steadies the gun at the cascable.

Exercise of the Sling-cart.

The complement of men for a sling-cart is one non-commissioned officer and six gunners.

Left side.	*Right side.*
No. 3 has charge of the left lever, and when necessary assists to skid the gun.	No. 2 has charge of the right lever, and when necessary assists to skid the gun.
No. 5 assists No. 3 at the lever and skidding, and when the gun is lashed assists in raising the breech.	No. 4 in like manner assists No. 2, and when the gun is lashed assists in raising the breech.
No. 7 assists No. 3 at the lever, slings and unslings the gun, and lashes it to the pry-pole.	No. 6 assists No. 2 at the lever, slings and unslings the gun, and lashes it to the pry-pole.

The non-commissioned officer puts in and takes out the pauls, and commands.

Exercise of the Devil-carriage.

The complement of men for working this carriage is one non-commissioned officer and ten gunners.

Exercises.

Left side.	*Right side.*
No. 2 has charge of a drag-rope, assists in hauling the perch up and down, assists No. 3 in bearing the muzzle down, and, when the gun and carriage are lashed on, puts up the skid.	No. 3 has charge of a drag-rope, assists in hauling the perch up and down, bears the muzzle of the gun down, and, when the breech is raised, puts the lever into the muzzle.
No. 4 steadies the gun-carriage when raised on its breast transom, and with the long guy-rope lashes its front axle-tree to the devil-carriage.	No. 5. The duties of No. 5 are in all respects the same as those of No. 4.
No. 6 slings the gun, lashes the breech to the perch, assists in limbering up and unlimbering, and slings the gun-carriage.	No. 7. The duties of No. 7 are the same as those of No. 6, only performed on his own side of the carriage.
No. 8 has charge of one of the short guys, assists in unlimbering and limbering up, and in hauling the breech of the gun up to the perch; lashes the hind axle-tree of the gun-carriage to the devil-carriage, and fixes the long guy-rope to the iron eyes at the end of the perch.	No. 9 does the same as No. 8.
No. 10 assists in unlimbering and limbering up, and in hauling the breech of the gun up to the perch; lashes with the short guy-ropes the rear-axle-tree of the gun-carriage to the devil-carriage, and fixes the short guy-ropes to the ring under the perch.	No. 11 does the same as No. 10.

The several exercises which have been here explained afford but a very faint view of the admirable course of instruction which is assiduously and regularly carried on in the Royal Repository at Woolwich, and through which every gunner and every officer must necessarily pass. When it is considered that artillery men are required to handle heavy ordnance under circumstances sometimes of peculiar difficulty, and to provide for their transport sometimes up inclined planes, and sometimes over broken bridges or other obstructions, it will be readily conceived how important it must be that they should be fully and most carefully trained to the ready and skilful application of mechanical contrivances; and it is in this excellent establishment, now presided over by Colonel Hardinge, that they are experimentally made acquainted with them. All the military machines now in use, Pontons, models of various systems of temporary bridges, including the most simple as well as the more complex, are to be seen in the grounds or in the model-room; and every operation connected with them is taught practically at the establishment. It may then be confidently asserted, that much of the efficiency of the artillery is due to this branch of its instruction.

Rockets.

As this missile, though depending for its movement on the progressive or comparatively gradual combustion of an explosive, or rather highly inflammable compound, has been classed by all modern artillerists rather with ordnance than with the musket, or other more handy weapons of personal conflict, it is necessary to make some further remarks upon its application in war. But before doing so it is right to explain the principle of its movement, as the improvement of the rocket as an efficient projectile will depend greatly on a right understanding of this principle. Mariotte and Nollet ascribed the movement of the rocket to the re-action of the gas proceeding from the combustion of the powder, produced by the resistance of the air to its escape from the vent. Desaguliers and D'Antoni reject the instrumentality of the air, and consider the movement of the rocket to be solely due to the greater re-active force of the gases on the head of the rocket than on its base. The first theory appears to have been adopted in the Woolwich School of Artillery until very recently; but the latter, which is without doubt the true theory, is now taught by the present able inspector, a professor of artillery, Captain Boxer, R.A., and is fully adequate to explain the motion of rockets, and all similar cases of motion either in animals or in machines. A very few words will make it quite intelligible, and show that motion will be produced under such circumstances *in vacuo*, as well as in air or water. Let the case of the rocket be first considered as closed on every side; in this instance the gas formed by combustion will accumulate in the case, and exercise a pressure increasing with the increase of quantity, or the degree of compression to which it is subjected; but as the pressure will be equal in all directions, the rocket will be urged backwards with the same force that it is urged forwards, and hence must remain at rest. Let it be supposed, then, that the pressure on the head, and on the base of the rocket case is each equal to $(a + b)$ lb., and that a hole be then made in the base which will relieve a portion of the pressure equivalent to b lb., by allowing the gas to escape: the pressure now, on the head, will be $(a + b)$ lb., and on the base a lb., so that the rocket being impelled forwards by a force equal to $(a + b)$ lb., and backwards by a force of a lb., will be forced into motion by a resultant force equal to b lb. This resultant force, to induce motion, must be greater than the weight of the rocket, when the projectile is intended to be fired vertically, and greater than a weight equivalent to friction and inertia, when the projectile is intended to be fired horizontally.

The rocket, as an instrument of war, is associated in the English mind with the name of Congreve, although Sir William Congreve was not its inventor. The merit of that very able officer consists in his appreciation of the value of rockets, and in his ingenuity and skill in improving them. It is not improbable, that the Greek fire of the ancients may have been sometimes projected in the manner of rockets; and it is certain that in Asia they were used with other fireworks on days of public festivals at very remote epochs. M. de Montgery[1] has collected the following recorded examples of their use in war. By the Chinese in their wars with the Tartars, at the commencement of the thirteenth century; by the Paduans and Venetians in 1379 and 1380; by the French in 1428, in the defence of Orleans; and in 1449, in the attack upon Pont-Audemer, when Dunois threw rockets into the place and took it by assault during the confusion of the conflagration which followed. In 1561, it was stated that careful descriptions of flying and destructive fuses (rockets) were found in an ancient manuscript, and that it was recommended to *make their cases of sheet-iron*, and to varnish them as a security against rust. Louis Collado, the author of a *Manuel d'Artillerie*, states, in 1586, that rockets were used to light up the vicinity of besieged places, and to throw cavalry into confusion; and recommends that *a petard should be added to them*, in order to render them more dangerous, and that they should *be projected by means of a long tube*, in order to increase their range. Towards the end of the seventeenth century, and during the eighteenth, rockets appear to have fallen into disuse as weapons of war in Europe, although some experiments were made by Ruggieri, both on fire-rockets and on grenade rockets. In Asia they continued to be used, and at the siege of Seringapatam, were

[1] *Journal de Sciences Militaires*, 1825-26.

projected against the English troops with considerable effect. They were made of sheet iron, and provided with a stick or tail of bamboo. The idea of using rockets in war first occurred to Sir W. Congreve in 1804; but as he states the fact, that in India they had been already thus used, and that General Desaguliers had some years before made experiments upon them, it is manifest he did not claim the title of inventor, but merely claimed the merit of making them of large size, and bestowing upon them a sufficiently extended range, as he certainly did when he constructed one of 32 lb. weight, having an average range of 3000 yards. In 1806, they were first used by the English fleet against Boulogne; in 1807, against Copenhagen, under the superintendence of Congreve; in 1809, in the Walcheren expedition; and subsequently, with brilliant success at Leipzig, where the rocket troop, under the gallant Captain Bogue, who fell gloriously in the battle, distinguished itself. M. de Montgery remarks justly, that the rockets now called Congreve rockets, though at present looked upon as one of the most recent inventions in artillery, are, on the contrary, one of the most ancient. But at the same time he does full justice to Sir W. Congreve; for, as he observes, "Some persons in England and in France have disputed with that active and ingenious officer the invention of war rockets; but as they had been previously employed in Europe, and were still employed in Asia, he could only reasonably claim the merit of having revived their use and perfected their construction, and that he most undoubtedly did."

Of the importance of war rockets, Sir W. Congreve had the very highest opinion. He preferred their employment with infantry as ground rockets, and pointed out the fearful effects of a shower of 1000 such rockets, ploughing up the ground as they ricocheted along, and never rising for the first 400 yards above the height of a man. He pointed out their peculiar applicability to mountain warfare, and the ease with which they might be used by cavalry and in boats. He considered that they were superior to ordinary artillery, and even to shrapnel shells; both from the ease with which they could be transported and managed, and from the greater quantity of missiles which they could discharge in a given time. And, finally, he proposed to use them, not merely in defence, but also in the battery of attack for breaching, stating, that from his experiments, he was disposed to believe that rockets weighing from half a ton to a ton might be made and projected, and that such masses inclosed in cast-iron cases would, by their weight, penetrate into the *revêtement* of a fortress, and by their subsequent explosion effectually destroy it.

Without however concurring in all the expectations of Sir W. Congreve, or undervaluing the objections which have been urged against rockets, many of which may certainly be removed by improved construction, it may be fairly urged that the time has arrived when more attention ought to be paid to the construction and improvement of this valuable description of artillery, which may assuredly be used in positions and under circumstances where no other could be applied.

For the projection of case shot and of all missiles which should possess a penetrative power as well as an explosive force, the rocket possesses an advantage in long distances over the howitzer shell, as its velocity and penetrative force then exceeds those of a shell. M. de Montgery gives the following table exhibiting the velocities and penetrative power of a howitzer shell, 6 inches in diameter, weighing 23 lb., and projected at an angle of 40°, with a velocity of 950 feet per second, as compared with a rocket 3½ inches in diameter, and weighing with its stick 42 lb. in French measure.

Distances from the point of discharge.	Calculated Velocities.		Weight of the Rocket.	Penetrations in Earth by calculation.	
	Of the Shell.	Of the Rocket.		Of the Shell.	Of the Rocket.
Toises.	Feet.	Feet.	Pounds.	Feet.	Feet.
0	950	0	42	7·0	0·0
100	850	158	37	5·5	0·9
200	760	224	34	4·4	1·7
300	680	274	32	3·5	2·4
400	608	316	30	2·8	3·0
500	544	354	28	2·3	3·8
600	486	387	27	1·8	4·0
700	435	418	26	1·4	4·8
800	389	447	25	1·2	5·2
900	357	474	24	1·0	5·4
1000	338	500	23	0·9	5·7
1100	364	530	23	1·0	6·4
1200	385	565	23	1·1	7·3
1300	414	605	23	1·3	8·4
1400	451	650	23	1·6	9·7
1500	510	700	23	2·0	11·0

This Table, founded on calculation alone, can be only considered, in the present state of knowledge on the subject, of approximative value. It appears from it, that at 700 toises, or about 1400 yards, the velocities of the two projectiles are nearly the same, whilst the penetrative power of the rocket is more than three times greater than that of the shell, so that the rocket might be employed with great advantage in enfilading from great distances. When the distance is small the advantage is on the side of the shell, but at 800 yards the velocity and penetrative power are still quite sufficient to render heavy rockets most effective projectiles for any purpose; and with the knowledge that musketry will henceforth be effective at 600 yards, it is desirable that projectiles capable of fulfilling the functions of both musket and cannon should be brought into action at about that distance. In Denmark, under the directions of the late Captain Schumacher, brother of the celebrated astronomer, numerous and careful experiments were made with rockets, and it appears that shells, grenades, and case shot were successfully projected in connection with these projectiles, and were deemed so effective that rockets became a part of the recognised armament of the gun boats, and were combined with guns and howitzers in the field artillery used for the defence of the coast of Zealand. It was from information given by Captain Schumacher to Captain Brulard that rockets were for a short time introduced into the French artillery, but they do not seem to have subsequently made much progress in that country. In Austria the manufacture of rockets has been carried to the highest perfection; and it has been considered so important that the government has formed a large establishment near Vienna, Raketendorff, for the express purpose both of making and trying rockets, four companies of artificers organized for this particular duty being regularly trained and exercised within a vast inclosure attached to the establishment, the greatest secrecy being observed, and the public rigorously excluded from the premises.

The experiments of Captain Brulard were made by order of Marshal Davoust, who would have doubtless introduced this projectile into the French artillery, had not the course of military events been changed by the downfall of Napoleon. Marmont, another high military authority, has also given the following opinions in favour of rockets.[1]

"Every day the office of artillery in war is becoming more important, not merely on account of the augmentation of the number of guns, but also from their increased mobility, which enables them to enter into almost every military combination. There is, however, a limit to this mobility, and

[1] *L'Esprit des Institutions Militaires.*

the difficulty and expense of moving guns under some circumstances must operate materially to check their use in inordinate numbers. The maximum ought not, indeed, to be placed higher than 4 pieces of ordnance for 1000 men; but rockets form an artillery the possible development of which is so unlimited that they may well form a principal and distinct arm of the service. In fact, when it is remembered that the rocket generates within itself the propelling force, and requires no propellent machine, that it offers no tangible object to an enemy's fire, that it can be fired in any position, and under any circumstances, requiring neither platforms nor other preparation, and that it may be so multiplied as to cover the front of a single regiment with a shower of shot equivalent to the fire of 100 guns, it may be assumed that nothing could resist its destructive action, and that it would be ruinous to expose to its force troops drawn up in parallel lines on the field of battle. To adapt the infantry to the use of this missile, it should be divided into two sections, one provided with rockets and the other intended to act as a covering party, so that the infantry would become a kind of infantry-artillery. This new artillery would become more especially useful in all situations unfavourable to the use of guns, such as mountainous ground, the tops of buildings and churches, producing the effect of a powerful battery without trouble, and in an instant; and it is by its fire and extended use that an overpowering effect can alone be expected, as one or two rockets fired here and there would frighten more than hurt.

"In such considerations as these it is usual that everything should move on in a routine system, and modifications or improvements be so slowly arrived at that it may be long before the real power and value of Congreve rockets will be duly appreciated; but should an able general, endowed with foresight (for example a master-general of the ordnance), take up the subject in all its bearings, and quietly organize such a rocket establishment as will enable the arm to be applied in its fullest development on the field of battle, he will ensure for his countrymen success in succeeding conflicts, which must continue to be unequal until his enemy has adopted the same means of offence.

"I repeat that rockets are destined to effect a revolution in the art of war, and that success and glory will crown the efforts of him who has the genius first to comprehend and apply the advantages to be expected from them."

These observations of so able an officer deserve consideration, and the more so as the brilliant service of the rocket troop, under the gallant Captain Bogue, appears to have been the primary cause of that marked attention which has been subsequently paid to this arm by foreign governments. M. Montgery,[1] after pointing out the various objects which might be embraced in the use of rockets—and in doing so, he falls little, if at all, short of the expectations of Sir W. Congreve—combats the prejudices of his countrymen in the following terms:—"It is no longer a question as to the adoption of an arm of doubtful utility, as rockets have now been so much improved by the hands of foreigners, that they have acquired incontestibly an advantage over guns, carronades, howitzers, mortars, and ordinary projectiles, and it would be an extreme of fatuity not to make use of them. Great obstacles, however, are likely to be thrown in the way of their general introduction into our armies and fleets, as the soldiers and sailors likely to be consulted on such a subject are high in rank and grown old in a course of service where such projectiles were nearly unknown, and can scarcely be expected to abandon their prejudices against untried novelties, or to recommend their use." Let another result be hoped for the British army, and as Sir W. Congreve revived the use of the rocket in Europe, so let some other British artillery officer—and there are many of them possessed of scientific knowledge sufficient to undertake the task—undertake the further improvement of so important a projectile, and place it in its proper rank in British artillery.

An examination of the following table of iron ordnance, will show, that a great advance has been made in one material element of improvement, namely, simplification; as the number of calibres has been diminished by the abandonment of the 56, 42, and 9 pounder iron guns. Including the 10-inch and 8-inch guns, the number of calibres has been thus reduced to 8, and the wants of the marine service met, by adopting a variation in length and width to suit the capabilities of vessels, rather than a variety of calibre. Many, however, of the pieces which still appear on the list may be considered experimental, and will be hereafter replaced by others so adjusted as to meet all contingencies, and yet considerably reduce the number. As a general principle, the rule already laid down should be adhered to, namely, that for long ranges, where great precision of fire is the main object, a long and heavy gun is necessary; and for short ranges, where rapidity of fire becomes indispensable, a short and lighter gun; and, consequently, that the same calibre should be represented in both long and short guns.

A simplification of a different kind has been proposed by Colonel Timmermans, in the artillery of defence, the object of which is to do away with the distinction of gun and howitzer, by the introduction of a gun-howitzer, the calibre being regulated in reference to the size of the shells. He thus proposes for the armament of a fortress six pieces, namely:—

				Cwt.	Lb.
Mortars of 29 centimetres,	or $11\frac{1}{2}$ in. calibre,	and weighing		23	64
Light do. of 29 do.	or $11\frac{1}{2}$ in.	...	...	4	102
Howitzers of 20 ...	or $7\frac{9}{10}$ in.	...	...	58	104
Short do. of 20 ...	or $7\frac{9}{10}$ in.	...	...	23	64

Gun-howitzers of $13\frac{3}{4}$ centimetres, or $5\frac{4}{10}$, being the calibre of an 18-pounder; and weighing 22 cwt. 66 lb., or about the same as an iron 18-pounder of 7 feet in length.

Mortar of $13\frac{3}{4}$ centimetres, or $5\frac{4}{10}$, and weighing 0 cwt. 77 lb.; this latter piece being about the calibre of the British cohorn, with the weight of a royal, or $4\frac{2}{5}$ calibre mortar.

These are all bronze pieces, and would reduce the calibres to three, namely, $11\frac{4}{10}$, $7\frac{9}{10}$, $5\frac{4}{10}$, but the system requires the test of experiment; and as it does not include the guns of attack, nor even those guns which would secure the long range necessary for early coast defence, it can only be looked upon as suggestive. In like manner, the Emperor of the French has proposed a gun-howitzer for the field, and General Lewis[2] makes a suggestion in the same direction, when he remarks on one of the inconveniences of the howitzer construction,—"Difficulties," he says, "occur in siege batteries when the howitzer is used, in consequence of the muzzle not entering into the throat of the embrasure; the cheeks are then blown away, and the men exposed after a few rounds are fired. Two expedients might be adopted to remedy this inconvenience; either to provide for mounting the 8-inch howitzer on garrison carriages, or to *lengthen the piece* to 8 calibres, corresponding with the 68-pounder carronade; but this last plan would involve difficulties in building a travelling carriage of sufficient strength."

The lightness, also, of Colonel Timmermans' guns would produce a very powerful action on the carriages, and lead to an excessive recoil, when fired with tolerable charges; but this evil he proposes to diminish, by using a less rapidly igniting powder; and it may be observed that it does not enter into his scheme to fire with charges exceeding from $\frac{1}{4}$th to $\frac{1}{5}$th, or to attain initial velocities beyond 1300 feet for the solid shot of his $7\frac{9}{10}$ gun-howitzer, or 1381 feet for his $5\frac{4}{10}$ gun-howitzer; the principle he advocates being great momentum rather than great velocity.

[1] *Histoire des Fusées de Guerre*, 1841.

[2] *Aide Memoire.*

Table of Iron Ordnance.—1853.

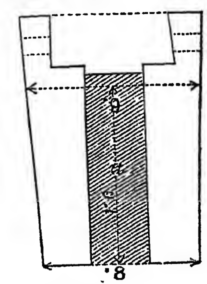
Nature of Ordnance.	Calibre, or weight of shot.	Service designed for.	Length. Feet & inches.	Length. In number of calibres.	Calibre in inches.	Length of bore.	Wght. cwt.	Extreme charge in lb.	Projectiles used, and weight in lb. and oz. Shells, &c., supposed charged. Solid shot.	Hollow shot.	Common shells.	Shrapnel shells.	Common case.	Grape.	Carcasses.	Carriages. Garrison. Sliding.	Garrison. Common.	Garrison. Iron.	Ship. Sliding.	Ship. Common.	Travelling or siege limber.	Weight of gun, limber, wagon, ammunition, &c.
			ft. in.		in.	ft. in.	cwt.	lb.	lb.	lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	cwt. lb.	cwt. lb.	cwt. lb.	cwt. lb.	cwt. lb.	cwt. lb	
Guns, iron	10-inch	Sea	10 6	12·0	10·0	10 1·2	112	16	...	86	82 0	...	82 7	81 8	96 4	...	...	...	...	...	...	...
Do.	do.	Land	9 4	11·0	10·0	9 1·3	86	12	...	86	82 0	...	82 7	81 8	96 4	...	...	...	...	...	...	...
Do.	8-inch	Sea & Land	9 0	13·3	8·05	8 9·3	65	10	...	56	50 0	61 1	48 12	50 7	50 12	13 28	15 70	25 38	9 84	9 10	...	...
Do.	do.	Sea	8 10	13·05	8·05	8 7·4	60	10	...	56	50 0	61 1	48 12	50 7	50 12	...	...	...	...	9 10	...	...
Do.	do.	Sea & Land	8 0	11·82	8·05	7 10·6	52	8	...	56	50 0	61 1	48 12	50 7	50 12	...	...	...	8 84	8 11	...	...
Do.	68-pr.	Land	10 10	16·15	8·12	10 3·4	112	20	68	...	48 0	61 1	50 4	50 7	50 12	16 26	...	...	...	...	...	...
Do.	do.	Sea	10 0	14·78	8·12	9 3·1	95	16	68	...	50 0	61 1	50 4	50 7	50 12	...	...	...	12 56	10 70	...	..
Do.	do.	Sea	9 6	14·00	8·12	8 11·7	87	14	68	...	50 0	61 1	50 4	50 7	50 12	...	...	...	12 24	...	...	...
Do.	32-pr.	Sea & Land	9 6	17·78	6·41	8 11·2	56	10	32	...	22 12	30 14½	34 13	29 11	24 8	12 51	15 30	23 50	9 56	8 108	...	...
Do.	do.	Sea	8 0	14·96	6·41	7 5·2	50½	8	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	...	7 84	...	...
Do.	do.	Sea	9 0	16·94	6·37	8 7·1	50	8	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	7 56	7 67	...	...
Do.	do.	Sea	8 6	16·06	6·35	8 1·2	45	8	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	7 21	7 67	...	...
Do.	do.	Sea & Land	8 0	15·12	6·35	7 7·3	42	6	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	7 4	...	...	...
Do.	do.	Sea	5 4	10·16	6·3	5 4·0	25	4	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	5 0	4 84	...	...
Do.	do.	Sea	5 4	10·16	6·3	4 9·9	25	4	32	...	12 12	30 14½	34 13	29 11	24 8	...	...	...	5 0	4 84	...	...
Do.	24-pr.	Land	9 6	19·58	5·82	8 11·4	50	8	24	...	15 2	21 4	24 10	20 10	17 4	10 18	13 79	21 76	...	7 76	31 54	...
Do.	18-pr	Land	9 0	20·41	5·29	8 5·8	42	6	18	...	...	15 10	19 11	16 12	14 7	9 34	12 84	19 8	...	5 101	26 0	103·76
Do.	do.	Sea	7 0	16·25	5·17	6 6·5	22	3	18	...	...	15 10	19 11	16 12	14 7	...	...	...	...	5 38	...	...
Do.	12-pr.	Land	6 0	15·58	4·62	5 6·5	21	4	12	...	7 5	10 13	12 2	11 2	9 6	...	...	...	...	...	18 33	...
Do.	6-pr.	Land	6 0	19·63	3·67	5 7·0	17	2	6	...	...	5 7½	5 10	5 7	...	...	9 20	14 87	...	5 38	...	...
Guns bored up from lower calibres.	32-pr. from 24-pr. of 46 cwt.	Sea	7 6	14·17	6·35	6 11·4	40	6	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	6 35	6 4	...	...
Do.	Do. from 24-pr. of 33 cwt.	Sea	6 6	12·38	6·3	5 11·8	32	5	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	6 79	5 108	...	...
Do.	Do. from 18-pr. of 27 cwt.	Sea & Land	6 0	11·43	6·3	5 7·8	25	4	32	...	22 12	30 14½	34 13	29 11	24 8	...	...	...	5 0	4 84	...	...
Do.	24-pr. from 12 pr............	Land	6 0	12·3	5·82	...	20	2½	24	...	15 2	21 4	24 10	20 10	17 4	...	13 79	21 76	...	...	...	...
Do.	18-pr. from 12 pr. of 21 cwt.	Sea	6 0	13·90	5·17	5 6·0	20	3	18	...	...	15 10	19 11	16 12	14 7	...	...	...	...	5 38	...	...
Do.	Do. from 9-pr. of 17 cwt...	Sea	5 6	12·76	5·17	5 0·7	15	2	18	...	...	15 10	19 11	16 12	14 7	...	...	...	...	5 38	...	...
																	Block Trail.					
Carronades	32-pr.	Sea	4 0	7·68	6·25	3 6·6	17	2·10	32	...	...	...	20 13	30 6	...	...	8 108	11 84	...	...	...	...
Do.	24-pr.	Sea	3 7½	7·79	5·58	3 2·8	13	2·0	24	...	...	...	16 13	20 9	...	...	7 105	10 104	...	...	...	...
Do.	18-pr.	Sea	3 3½	7·06	5·16	3 0·3	10	1·8	18	...	...	...	12 14	15 10	...	...	6 104	9 66	...	...	...	...
Do.	12-pr.	Sea	2 8¼	7·14	4·52	2 4·7	6¾	1·0	12	...	...	...	11 9	11 1	...	...	6 28	8 40	...	...	...	...
Howitzers	10-inch	Land	5 0	6·00	10·00	4 10·8	41	7	...	...	90 0	...	86 0	81 8	96 4	...	16 0	...	...	...	30 10	...
Do.	8-inch	Land	4 0	6·00	8·00	3 10·8	21	4	...	...	48 0	61 1	36 0	50 7	50 12	...	14 8	...	...	...	39 10	...
																		Bed.				
Mortars	13-inch	Sea	4 4	4·00	13·00	...	100	20	...	...	196½ 0	...	...	...	212 14	...	...	...	...	...	31 98	...
Do.	do.	Land	3 3½	3·01	13·00	2 0·5	36	9	...	...	196½ 0	...	...	...	212 14	...	...	31 0	...	...	...	...
Do.	10-inch	Sea	3 9	4·50	10·00	...	50	9½	...	...	90 0	...	...	...	96 4	...	...	...	...	...	...	...
Do.	do.	Land	2 7½	3·15	10·00	2 1·0	18	4	...	...	90 0	...	...	...	96 4	...	...	16 44	...	...	...	...
Do.	8-inch	Land	2 1¼	3·16	8·00	...	9	2	...	...	43 0	...	...	...	50 12	...	...	7 56	...	...	...	...

The improvement of the projectiles used is the next object of importance. The use of solid shot cannot be dispensed with, even when the action of artillery is directed against infantry, as the moral effect of its ravages is very great upon the soldier. Many modes, therefore, of increasing the precision of fire with such projectiles have been proposed, such as rifling the guns, covering the balls with lead or combining that metal with the iron in some other way so as to facilitate the rifling process, oval balls, &c.; and experiments are still in progress for the same purpose. But allowing every possible weight to the effects of solid shot, the shrapnel shell appears to be the most important and destructive projectile which has hitherto been invented for the purposes of war, as it combines the action of small shot with the extensive range of a cannon-ball or shell; and in the larger calibres, the moral effect of the cannon-ball might be secured in combination with its wide-spread action, by such a modification of the shell as would allow the use of large iron balls as in common case. At present, the effect of such projectiles may be understood from a consideration of the number of balls projected in each shell; thus—68-pounder, and 8-inch gun or howitzer, 377; 32-pounder, 204; 24-pounder, 128; 18-pounder, 90; 12-pounder, 63; 6-pounder, 27. One difficulty, however, attends the use of the shrapnel hitherto constructed; namely, the frequent ignition of the bursting powder, from the heat generated by friction between the balls; and the necessity, therefore, of using a diminished charge, with a corresponding loss in the extent of range. This evil it has been attempted to remedy by placing the powder in the centre of the balls; but the result of this arrangement is, that the balls receive an impulse from the bursting powder which may deflect them from their course, or even stop their further progress by neutralizing their remaining velocity. The most natural mode would appear to be a separation of the powder from the balls; a plan which was suggested about four years ago by Captain Boxer, R.A., but not then adopted by the artillery committee, who considered that a reduced charge was the simplest mode of lessening the chance of premature explosion, and did not, at that time, appear to think a great range so essential as it manifestly is. On the continent this plan has also been proposed; and the indefatigable inventor of it in this country has, by perseverance and skill, at length produced a shrapnel shell which may be fired with any amount of charge, and will be effective at any range. By its construction this shell will admit of the use of at least 1-lb. iron balls, and, as it may be fired even from mortars, the vertical fire of Carnot will no longer be an illusion, but will realize in its destructive effects the expectations of that author.

A shell, it will be observed, depends, as to the time of bursting, on the length of the fuse attached to it. The fuse is a short wooden pipe, somewhat like the wooden tap of a beer-barrel, being cylindrical within and slightly conical without; it is filled with a peculiar composition, and being driven or fixed into the fuse-hole of the shell, the priming ignites when the gun is fired, and on the composition burning through, the flame is communicated to the bursting powder within the shell, which then explodes. The time of bursting, therefore, depending on the length of fuse to be burnt, used to be regulated either by cutting the fuse to the required length in the field, or by boring out a portion of the composition; but these very rude systems will now be replaced by the simple but excellent fuse called Boxer's fuse, being another invention of that able and scientific officer. The beauty and simplicity of Captain Boxer's improvement of the fuse will be readily understood from the annexed woodcuts, the first of which represents the common shrapnel fuse, in which the time of burning has to be regulated by boring out a portion of the composition from the bottom of the fuse, and thus reducing the quantity to be burnt, and therefore the time of burning; the second, Boxer's fuse, in which a communication is made between the burning fuse composition and the bursting powder through the auxiliary tube *c*, by boring through the intervening side of the fuse (which is very easily done) at the proper opening *f*, corresponding to the required range, and marked on the external covering of the fuse. In this latter arrangement there can be no mistake, no chance of boring too much or too little, and no necessity of wasting time in guessing the quantity.

COMMON SHRAPNEL FUSE.

(*a*) Fuse composition which has to be bored out from the bottom for any particular range.



BOXER'S SHRAPNEL FUSE.

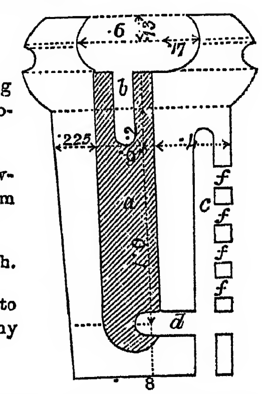
(*a*) Fuse composition.

(*b*) Small hole drilled through priming and composition, to insure the proper ignition of the fuse.

(*c*) Channel filled with fine grain-powder to communicate the fire from the fuse to the bursting powder.

(*d*) Side-hole containing quick-match.

(*f*, *f*, *f*) Side-holes to be continued into the composition in the field for any particular range.



Combining the improvement of the shrapnel shell and the improvement of the fuse, it may be reasonably expected that bursting in the gun or just beyond the muzzle, bursting at uncertain distances, and blind shells or shells bursting not at all, will cease to be the ordinary accidents of artillery practice.

On referring to the table of brass or bronze ordnance, it will be observed that the number of pieces is still considerable, being at least 12, and indeed sometimes reckoned as 13, whilst the number of calibres is 9, or may be reduced to 7 by classing together those of which the difference is small, and which may therefore be considered applicable for the propulsion of the same projectiles, with different degrees of windage. Such an arrangement renders it necessary to class together guns and howitzers of different calibre in the same battery, a system which, though now unavoidable, must be considered defective; the 24-pounder howitzer being classed with the 9-pounder in the field batteries, the 12-pounder howitzer with the 6-pounder in the horse or cavalry batteries, and the 32-pounder howitzer with the 12-pounder in batteries of position, so that the ammunition, case-shot, &c., of one cannot be used with the other. The present Emperor of the French has, indeed, in reference to these defects, proposed the adoption of a 12-pounder howitzer-gun as the single calibre to be used in the field; the weight being 11 cwt. 18 lb., or 2 cwt. 38 lb. less than the weight of the British 9-pounder. This howitzer-gun, mounted on the carriage of a French 8-pounder, corresponding nearly to a 9-pounder English, would, on account of its lightness, require to be fired

Artillery.

with a charge of one-fourth instead of one-third. The simplification thus effected would indeed be very important; but those who are well acquainted with the destructive effects on the carriage of firing from light guns, will at least require very careful preliminary experiments. As yet, in the British service, such experiments have not been considered favourable to the use of guns of diminished weight; but it may be possible that a howitzer-gun in weight between the 9-pounder and 12-pounder, and of the calibre of the 12-pounder, would be found efficient, with a reduced charge, for any service or range required in the field, or in movements of combined infantry and artillery.

Artillery.

Table of Brass or Bronze Ordnance.—1853.

Nature of ordnance.	Calibre, or weight of shot.	Service designed for.	Length. In feet and inches.	Length. In calibres.	Calibre, in inches.	Length of bore.	Wght. in cwt.	Charge in lb.	Nature and Weight of Projectiles. Solid shot.	Common shell filled.	Common case.	Spherical case.	Carcasses.	Carriages. Carriage, limber, ammunition, stores.	Waggon limber, ammunition, stores.	Spare wheel carriage, limber stores.	Total weight conveyed on the field.
			ft. in.			ft. in.		lb. oz.	lb.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	cwt. lb.	cwt. lb.	cwt. lb.	cwt. lb.
Gun	12-pr. (medium)	Land	6 6·6	17	4·62	6 2·5	18	4	12	...	16 14	10 13¼	8 13	44 17	36 37	30 43	128 97
Do.	9-pr.	Land	6 0	17	4·2	5 7·7	13½	3	9	...	13 2½	8 1¼	...	38 65	34 45	29 71	116 13
Do.	6-pr. (light)	Land	5 0	16·3	3·7	4 9·5	6	1 8	6	...	9 0	5 7¼	...	28 23	33 92	26 82	94 85
Do.	3-pr.	Land	4 0	16·4	2·9	3 10	3	0 12	3	...	...	...	...	26 71	30 53	24 85	84 97
Do.	3-pr.	Land	3 0	12·3	2·9	2 10	2¼	0 10	3	...	...	...	...	12 95	6 52	...	21 63
Do.	1-pr. (mountain)	Land	5 0	29·8	2·01	4 10	2½	0 6	1	...	...	...	...	...	...	...	13 51
Howitzer	32-pr.	Land	5 3	10	6·3	5 1·2	17½	3	...	...	...	...	...	...	...	...	...
Do.	24-pr.	Land	4 8·6	10	5·72	4 7·1	12½	2½	...	14 10½	19 8	21 4	16 9½	39 39	35 48	...	87 31
Do.	12-pr.	Land	3 9·2	10	4·58	3 9·1	6½	1¼	...	7 5½	11 9	10 13¼	8 13	29 17	31 69	...	67 30
Do.	4⅖-inch	Land	1 10½	4·9	4·52	1 4·1	2½	0 8	...	7 5½	...	...	8 13	13 11	7 26	...	22 93
														Bed alone.			Without ammunition.
Mortar, royal	5½-inch	Land	1 3	2·6	5·62	0 11·9	1¾	0 7	...	14 10½	...	...	16 9½	1 10	...	...	2 94
Do., cöhorn	4⅖-inch	Land	1 0½	2·6	4·52	0 10·1	1	0 5	...	7 5½	...	...	8 13	0 89	...	...	1 89

In a preceding paragraph, the necessity of securing artillery from the effects of the fire at long ranges of the improved musket, by causing the guns to co-operate with riflemen, or with troops armed with this musket, has been strongly urged; and whilst in the press, the system of manœuvring artillery and infantry together, making the infantry the adjunct of the artillery, and not as heretofore the artillery the adjunct of the infantry, has been tried on a large scale at Vincennes; batteries having been thus formed in combined squares with the infantry, so that the latter could at once support the artillery and be supported by it. Such an experiment is an argument for securing an amount of speed or facility of movement equal to the most rapid movements of infantry, but not for going beyond that speed at the sacrifice of weight of metal; and it is equally an argument for obtaining a large calibre for the efficient use of spherical case. These conditions would probably be satisfied by a gun intermediate between the 9 and 12 pounder; as, for example, an 11-pounder, the calibre of which would be 4·5, therefore but little less than the calibre of a 12-pounder or a 10-pounder, the calibre of which would be about 4·35. Before closing these remarks, it may be well to reiterate the principles which have been already laid down as a guide in every attempt to improve field artillery; namely, 1*st*, that in the field or infantry batteries, the highest calibre consistent with a moderate degree of mobility; and, 2*d*, that in horse or cavalry artillery, the greatest speed consistent with a reasonable calibre—should be the objects sought for. All attempts to confound these principles together, will only lead to imperfect designs and ultimate failures in the field of actual service. It has, for example, been again proposed to replace the 6-pounder as a gun for the horse artillery by the 9-pounder; but the propriety of such an arrangement is at least very doubtful, as may be judged from the following considerations:—The weight of the 6-pounder with its limber, ammunition, and stores, is 28 cwt. 23 lb., and that of the 9-pounder, 38 cwt. 65 lb., being 10 cwt. 42 lb. more than the 6-pounder; or, as the weight of the two men carried on the limber will be common to both, the aggregate weights may be stated at 31 cwt. 23 lb. and 41 cwt. 65 lb.; the 9-pounder, therefore, exceeding the 6-pounder by about one-third of the whole weight of the former. At first sight it may be supposed that the addition of two horses (the number becoming six) will more than counterbalance this increase of weight, the power being in fact augmented by one-half instead of one-third; and unquestionably, on moderately level ground such as the common at Woolwich it would do so; but results of this kind are delusive when applied to other circumstances. Over rough ground the shocks to the carriage would be greatly increased by the additional weight, and in bad roads would so add to the strain on the horses that speed would often be impracticable. In passing over, also, such ground as must be frequently embraced by military operations, the traction will often fall entirely on the four rear horses, and sometimes even on the last two; and in such cases what must be the result of the increase of weight! Nor is this all, as the more the number of horses is increased, the more must the chances of being crippled by the loss of one or more horses be increased also; and it would, therefore, be better, were it possible to do so, to diminish the number of horses actually attached to the gun, and to keep more in reserve. In the ammunition waggons, also, that of the 9-pounder exceeds by about 5 cwt. that of the 6-pounder; and finally, it may be observed, that though an increase in the number of horses may under some circumstances keep up the required speed with a heavier gun; as a general rule, it will be found that the same analogy exists between the heavy and light gun as between the heavy and light coach, and that additional weight will therefore be moved either with a less velocity, or at the expense of frequent injury and destruction of both carriages and horses.

It is hoped that the perusal of this essay, though addressed rather to the general reader than to the more trained artillerist, will leave an impression on the mind of the great national importance of the arm of the service to which it relates, and of the necessity, as so strongly urged by one of its able members, Lieut. Jervis, in his work on *Tactics*, of establishing the training of its officers and men on a sound scientific basis. In all nations this has been felt, and schools of artillery and engineering have been established for the purpose of such training; a task confided in this country to the Royal Military Academy at Wool-

wich. On such a subject it might be supposed there could be little difference of opinion; but such is not the case, as some officers form a high estimate of the necessary qualifications of an artillery officer, looking not merely to the ordinary details of a parade or of a field-day, but to the knowledge which must be often called for in the many combinations and applications of so powerful an instrument of war; whilst others lower the standard of qualification, and because they have got through much rough work with honour, and yet with little science, maintain that the artillery officer may be made perfect without much theoretical knowledge. The true medium is between these extremes; for whilst the officer should not become too speculative, but be accustomed at every step of his theoretical education to refer his science to its practical application, he should never be allowed to think that ignorance of the science of his profession can be tolerated in the officer of such a corps. Let it also be remembered, that the great establishments of the arsenal, such as that of the inspector of artillery, of the royal carriage manufacture, and of the royal laboratory, are presided over by artillery officers, and yet are in their very essence eminently theoretical. The construction of a gun or of a carriage, and the manufacture of a rocket, of a fuse, or of a tube, are closely connected with theoretical questions of much delicacy; and it would be a mockery to expect that the departments under which they are conducted should keep pace with the progress of an age so distinguished for mechanical invention, unless presided over by men who add to their practical experience sound theoretical knowledge. Experiments may, indeed, be proposed and performed, alterations may be suggested and made, but few and far between will be the real improvements effected; and the British artillerist will be contented to follow where he ought to lead in the advancement of his profession. There is an academy, there are most able masters, there is every possible appliance of instruction, and at every half-yearly examination some few at least talented and well-instructed officers are poured into the regiment of artillery; but can it be said that any one of them who has distinguished himself for mathematical, mechanical, or chemical acquirements can speculate on becoming inspector or assistant-inspector of artillery, director of the laboratory, or fire-master? Here is the great mistake! ambition, as a natural stimulus to excel in those studies which have been partially mastered at the academy, and the hope of presiding over departments dependent upon them, are not applied; and too often a cold chill comes over the mind, and the pursuit of knowledge is abandoned as leading to no certain future distinction. Reverse this arrangement, and whilst a due amount of honour and reward is freely granted to the old and distinguished soldier, let none be appointed to scientific establishments who are not themselves scientific; and it will soon be found that the academy at Woolwich is fully able to raise up men who will do honour to their country, not only as brave and skilful gunners, but as sound theoretical artillerists. How long, indeed, would the service have struggled against the defects of the old fuse and the imperfections of the old shrapnel, had not an able scientific officer applied his mind and talents to the study of artillery in all its branches, and thus acquired the power of pointing out the mode of remedying them; and is it chimerical to anticipate far greater inventions, when the minds of many such officers shall have been directed to the same studies, and been encouraged to pursue them, to the ultimate benefit and perfection of their professional science?

(J. M. S.) (J. E. P.)

ARTILLERY was formerly applied in a collective sense to all kinds of offensive weapons; but this use of the word is now generally restricted to poetry.—See 1 *Samuel* xx. 40.

ARTILLERY Park. This term, introduced into military science, has been derived from the French verb *parquer*, to *separate from others, and keep together in an inclosure.* The great number and variety of carriages, horses, and stores of all kinds which must be connected with the equipment of artillery, render it necessary that they should be kept together, and not confusedly mixed up either with the troops or with the stores of other arms of the service; and this expressive term, therefore, at once states a fact, and explains the reason of it. Following up the analogy with a park for cattle or for deer, the artillery park has been sometimes inclosed with a rope-fence; and when in a dangerous position, not entirely free from the chance of surprise or of attack from cavalry, by a row of waggons united together by their drag-chains, or indeed by any other description of protective fence. In a large army the greater proportion of the ammunition and stores, the pontoon establishment, and even the artillery of reserve, may be best brought together in one large depôt or park, called the grand park, which should be located in the vicinity of proper roads, and so placed as to be protected on all sides from attack; its natural position is therefore either between the main body of the army and the reserve, or in the reserve itself. From this locality the artillery of reserve, or the pontoons, can be despatched to the division or divisions selected for any forward movement. If the army be of such magnitude as to include several aggregates of divisions, or corps d'armée, the grand park will be located in the rear, so as to minister to the wants of all; and a park of reserve will be formed with each. This park will be located with the reserve of the corps it accompanies, and should comprise a considerable body of reserve artillery, in addition to reserves of every description from the artillery of each separate division. A complete veterinary establishment and a pontoon train should be connected with it, and an ample establishment of artificers. In the grand park, and in parks of reserve, should the army continue stationary for any length of time, every care should be taken to secure the horses from the weather, and a proper infirmary established to receive sick horses from the divisions, or from the corps in advance.

In respect to the divisions of the army, each should be accompanied by two complete field batteries, and at least half a horse battery, provided the division be constituted of 10 battalions of 800 men each, and is supported in its independent movement by a due proportion of cavalry. If not acting independently, the division of infantry will have the two batteries, and the division of cavalry at least one battery. But in addition to the batteries acting in the field with the infantry, there ought to be artillery of reserve with each division. The French system was to divide their artillery into three sections, viz., the guns of the advanced guard, composed of 4-pounders ($4\frac{1}{4}$ English); the guns of the field of battle, composed of 8-pounders ($8\frac{3}{4}$ English); and guns of reserve, 12-pounders (13 pounders English); and as in the English service the light 6-pounder of the horse artillery may be considered a representative of the French 4, it may be supposed that the horse artillery, supported by cavalry, will move with the advance, and that the 12-pounder will act with the reserve. On this supposition, if two 12-pounders were added to each field battery, making the total number eight, as suggested under the article ARTILLERY, a field battery would consist of four 9-pounders, two 24-pounder howitzers, and two 12-pounders, of which the two 12-pounders ought to be in the divisional park of reserve. This park, placed sufficiently in rear of the division not to be incommoded by the enemy's fire, will contain not only the two reserve 12-pounders of each battery, or four 12-pounders in all, but also the spare ammunition waggons, spare carriages

and wheels, &c., the forge-cart of each battery, spare horses, and the pontoon train if the division be expected to move forward independently. In the artillery parks of reserve of each denomination the spare ammunition for the infantry should also be lodged; and, for the regulation of all the proceedings connected with the care and issue of such various stores and ammunition, the park is presided over by a regular staff, and should be provided with storekeepers, artificers, and labourers, in each separate department.

It will be observed, that the pontoon train is here supposed to be attached to the artillery as it is in the French army; in the British service it is attached to the engineer department, but the propriety of this latter arrangement is at least doubtful, for although every engineer officer, and every sapper and miner, should be well trained in the construction of pontoon, as well as of all other temporary or service bridges, it is manifest that the transport and care of the pontoons may be best confided to the artillery. In fact, it is very desirable that the pontoons should be put upon a proper footing as to horses and conductors; and that the horses and men connected with them should have been trained to guns, so that on an emergency both men and horses might take their places with the guns, and thus postpone as long as possible any diminution in the efficiency of that most important arm of the service. The pontoon horses could at any time be replaced by ordinary draught horses, but not so the artillery horses in the field. The engineer officer and the sapper and miner might still direct and assist in the construction of bridges, but the gunners and drivers attached to the pontoons should be men fully acquainted with all the details of every operation connected with it, from practical experience gained in the repository course.

The field-park or encampment is the last to be considered, and this should conform to the following general principles of encamping:—

1. The different regiments or corps are encamped in the same order as they are intended to fight, whether in the centre or the flanks, the first or second line.

2. The front of the encampment of each regiment or corps should occupy the space which it will require in battle; or, in other words, the line of tents of all the regiments or corps should cover the line of battle, so that on any necessity or alarm, whether by night or day, the troops, when forming in front of their tents, may find themselves in their proper places in the line of battle.

Now, as the relative positions in the field of battle of the troops of different arms must depend on the distinctive peculiarities of the ground to be occupied, the sites of the parks of artillery can only be determined after a careful examination or reconnaissance of that ground; but as a rule to be rigidly observed, it should be stated that artillery should never depend for its protection against surprise on its own men, and therefore should not be placed on the extreme flank. In ordinary ground, the battery or batteries attached to a division, with one ammunition waggon to each gun (the remaining waggons being sent to the park of reserve), should take up their position in rear of the division, each being opposite the interval between two brigades, so that the guns may be moved to the front at a moment's warning.

Several systems of parking have been adopted—1*st*, Parking to the rear or behind the guns: thus, guns at full distance, as in action, in front row; ammunition-waggons in second; horses picketed in the third; tents, one to each subdivision, in the fourth; tents of subaltern officers in the fifth; and captain's tent in the rear. 2*d*, Parking to the flanks: guns at half distance in front; horses for the guns picketed in the second row; waggons in the third, and horses for them in the fourth row,—the subdivision and other tents being placed on the flanks in files from front to rear. 3*d*, Parking to the front and flank, as sometimes practised in the French army, when the tents of the gunners are pitched in front of the guns, so that the men form a guard to the guns, and the tents of the drivers on the flanks. Again, the horses have sometimes been picketed on the flanks; but, generally speaking, all other systems may be considered modifications of the above. In the park of reserve the same rules should be followed, though occasional modification, as to a greater or lesser frontage, may be allowed, provided a due regularity in the classification of stores be preserved.

Between the brigades, or halves of brigades, an interval of about 110 or 120 yards should be preserved, as the proper per-centage for a six-gun battery; and, if possible, the battery should be covered on its flank by at least half a brigade. (J. E. P.)

Artillery Train, a certain number of pieces of ordnance mounted on carriages, with all their furniture fit for marching.

ARTIST, in a general sense, a person skilled in some art. Mr Harris defines an artist to be "a person possessing an habitual power of becoming the cause of some effect, according to a system of various and well-approved precepts." It is generally applied to an individual who practises the liberal arts as a profession.

ARTOCARPIÆ, a sub-order, established by Robert Brown, under the URTICEÆ. It contains the bread-fruit tree, *Artocarpus incisa*. See BOTANY.

ARTOIS, the name of an old province of France, of which Arras was the capital. With part of Picardy it now forms the department of Pas de Calais.

ARTOTYRITES (from ἄρτος, *bread*, and τυρός, *cheese*), a Christian sect in the primitive church, who celebrated the eucharist with bread and cheese, on the ground that the first oblations of men were not only of the fruits of the earth, but of their flocks. The Artotyrites admitted women to the priesthood and episcopacy; and Epiphanius tells us it was a common thing to see seven girls at once enter into their church, robed in white and holding a torch in their hand, where they wept and bewailed the wretchedness of human nature and the miseries of this life.

ARTS.

ART is defined by Lord Bacon as a proper disposal of the things of nature by human thought and experience, so as to answer the several purposes of mankind; in which sense *art* stands opposed to *nature*.

Art is principally used for a system of rules serving to facilitate the performance of certain actions; in which sense it stands opposed to *science*, or a system of speculative principles.

Arts are commonly divided into useful or mechanic, fine or liberal. The former are those wherein the hand and body are more concerned than the mind; of which kind are most of those which furnish us with the necessaries of life, and are popularly known by the name of trades. The latter are such as depend more on the labour of the mind than of the hand; they are the produce of imagination and taste, and their end is pleasure.

USEFUL ARTS.

Some useful arts must be nearly coeval with the human race; for food, clothing, and habitation, even in their original simplicity, require some art. Many other arts are of such antiquity as to place the inventors beyond the

Useful Arts.

reach of tradition. Several have gradually crept into the world without an inventor. The busy mind, however, accustomed to a beginning in things, cannot rest till it finds or imagines a beginning to every art. The most probable conjectures of this nature the reader may see in the historical introductions to the different articles. Lord Kames, in his *Sketches of the History of Man*, has given some curious illustrations of the progress of the arts.

In all countries where the people are barbarous and illiterate, the progress of arts is extremely slow. It is vouched by an old French poem, that the virtues of the loadstone were known in France before the year 1180. The mariner's compass was exhibited at Venice anno 1260, by Paulus Venetus, as his own invention. John Goya of Amalfi was the first who, many years afterwards, used it in navigation, and also passed for being the inventor. Though it was used in China for navigation long before it was known in Europe, yet to this day it is not so perfect as in Europe. Instead of suspending it in order to make it act freely, it is placed upon a bed of sand, in which position every motion of the ship disturbs its operation. Handmills, termed *querns*, were early used for grinding corn; and when corn came to be raised in greater quantity, horse-mills succeeded. Water-mills for grinding corn are described by Vitruvius. Wind-mills were known in Greece and in Arabia as early as the 7th century, and yet no mention is made of them in Italy till the 14th. That they were not known in England till the reign of Henry VIII. appears from a household book of an earl of Northumberland, contemporary with that king, stating an allowance for three mill-horses, "two to draw in the mill, and one to carry stuff to and from the mill." Water-mills for corn must in England have been of a later date. The ancients had mirror-glasses, and employed glass to imitate crystal vases and goblets; yet they never thought of using it in windows. In the 13th century the Venetians were the only people who had the art of making crystal glass for mirrors. A clock that strikes the hours was unknown in Europe till the end of the 12th century; and hence the custom of employing men to proclaim the hours during night. Galileo was the first who conceived an idea that a pendulum might be used for measuring time; and Huygens was the first who put the idea in execution, by making a pendulum clock. Hooke, in the year 1660, invented a spiral spring for a watch, though a watch was far from being a new invention. Paper was made no earlier than the 14th century; and the invention of printing was a century later. Silk manufactures were long established in Greece before silk-worms were introduced there. The manufacturers were provided with raw silk from Persia; but that commerce being frequently interrupted by war, two monks, in the reign of Justinian, brought eggs of the silk-worm from Hindostan, and taught their countrymen the method of managing them. The art of reading made a very slow progress: to encourage that art in England, the capital punishment for murder was remitted if the criminal could but read, which in law language is termed *benefit of clergy*. One would imagine that the arts must have made a very rapid progress when so greatly favoured: but there is a signal proof of the contrary; for so small an edition of the Bible as 600 copies, translated into English in the reign of Henry VIII., was not wholly sold off in three years.

The discoveries of the Portuguese on the west coast of Africa is a remarkable instance of the slow progress of arts. In the beginning of the 15th century they were totally ignorant of that coast beyond Cape Non, 28 degrees north latitude. In 1410 the celebrated Prince Henry of Portugal fitted out a fleet for discoveries, which proceeded along the coast to Cape Bajadore, in 28 degrees, but had not courage to double it. In 1418 Tristan Vaz discovered the island Porto Santo; and the year after the island Madeira was discovered. In 1439 a Portuguese captain doubled Cape Bajadore; and the next year the Portuguese reached Cape Blanco, lat. 20 degrees. In 1446 Nuna Tristan doubled Cape de Verde, lat. 14. 40. In 1448 Don Gonzallo Vallo took possession of the Azores. In 1449 the islands of Cape de Verde were discovered for Don Henry. In 1471 Pedro d'Escovar discovered the island St Thomas and Prince's Island. In 1484 Diego Cam discovered the kingdom of Congo. In 1486 Bartholomew Diaz, employed by John II. of Portugal, doubled the Cape of Good Hope, which he called *Cabo Tormentoso*, from the tempestuous weather he found in the passage.

The progress of art seldom fails to be rapid when a people happen to be roused out of a torpid state by some fortunate change of circumstances. Prosperity, contrasted with former abasement, gives to the mind a spring, which is vigorously exerted in every new pursuit. The Athenians made but a mean figure under the tyranny of Pisistratus, but upon regaining freedom and independence they were converted into heroes. Miletus, a Greek city of Ionia, being destroyed by the king of Persia, and the inhabitants made slaves, the Athenians, deeply affected with the misery of their brethren, boldly attacked the king in his own dominions, and burnt the city of Sardis. In less than ten years after, they gained a signal victory at Marathon; and, under Themistocles, made head against that prodigious army with which Xerxes threatened utter ruin to Greece. Such prosperity produced its usual effects: arts flourished with arms, and Athens became the chief theatre for sciences, as well as for fine arts. The reign of Augustus Cæsar, which put an end to the rancour of civil war, and restored peace to Rome, with the comforts of society, proved an auspicious era for literature, and produced a cloud of Latin historians, poets, and philosophers, to whom the moderns are indebted for their taste and talents. One who makes a figure rouses emulation in all: one catches fire from another, and the national spirit is everywhere triumphant; classical works are composed, and useful discoveries made in every art and science. With regard to Rome, it is true that the Roman government under Augustus was in effect despotic; but despotism in that single instance made no obstruction to literature, it having been the policy of that reign to hide power as much as possible. A similar revolution happened in Tuscany about three centuries ago. That country having been divided into a number of small republics, the people, excited by mutual hatred between small nations in close neighbourhood, became ferocious and bloody, flaming with revenge for the slightest offence. These republics being united under the great duke of Tuscany, enjoyed the sweets of peace in a mild government. That comfortable revolution, which made the deeper impression by a retrospect of recent calamities, roused the national spirit, and produced ardent application to arts and literature. The restoration of the royal family in England, which put an end to a cruel and envenomed civil war, promoted improvements of every kind; arts and industry made a rapid progress among the people, though left to themselves by a weak and fluctuating administration. Had the nation, upon that favourable turn of fortune, been blessed with a succession of able and virtuous princes, to what a height might not arts and sciences have been carried!

Another cause of activity and animation is the being engaged in some important action of doubtful issue,—a struggle for liberty, the resisting a potent invader, or the like. Greece, divided into small states frequently at war with each other, advanced literature and the fine arts to

unrivalled perfection. The Corsicans, while engaged in a perilous war for defence of their liberties, exerted a vigorous national spirit; they founded a university for arts and sciences, a public library, and a public bank. After a long stupor during the dark ages of Christianity, arts and literature revived among the turbulent states of Italy. The Royal Society in London, and the Academy of Sciences in Paris, were both of them instituted after civil wars that had animated the people and roused their activity.

In a country thinly peopled, where even necessary arts want hands, it is common to see one person exercising more arts than one. In every populous country, even simple arts are split into parts, and each part has an artist appropriated to it. In the large towns of ancient Egypt a physician was confined to a single disease. In mechanic arts that method is excellent. As a hand confined to a single operation becomes both expert and expeditious, a mechanic art is perfected by having its different operations distributed among the greatest number of hands: many hands are employed in making a watch, and a still greater number in manufacturing a web of woollen cloth. Various arts or operations carried on by the same man invigorate his mind, because they exercise different faculties; and as he cannot be equally expert in every art or operation, he is frequently reduced to supply want of skill by thought and invention. Constant application, on the contrary, to a single operation, confines the mind to a single object, and excludes all thought and invention. In such a train of life the operator becomes dull and stupid, like a beast of burden. The difference is visible in the manners of the people. In a country where, from want of hands, several occupations must be carried on by the same person, the people are knowing and conversable: in a populous country, where manufactures flourish, they are ignorant and unsociable. The same effect is equally visible in countries where an art or manufacture is confined to a certain class of men. It is visible in Hindostan, where the people are divided into castes, which never mix even by marriage, and where every man follows his father's trade. The Dutch lint-boors are a similar instance: the same family carries on the trade from generation to generation, and are accordingly ignorant and brutish even beyond other Dutch peasants.

Useful arts pave the way to fine arts. Men upon whom the former had bestowed every convenience, turned their thoughts to the latter. Beauty was studied in objects of sight; and men of taste attached themselves to the fine arts, which multiplied their enjoyments and improved their benevolence. Sculpture and painting made an early figure in Greece, which afforded plenty of beautiful originals to be copied in these imitative arts. Statuary, a more simple imitation than painting, was sooner brought to perfection. The statue of Jupiter by Phidias, and of Juno by Polycletes, though the admiration of all the world, were executed long before the art of light and shade was known. Apollodorus, and Zeuxis his disciple, who flourished in the 95th olympiad, were the first who figured in that art. Another cause concurred to advance statuary before painting in Greece, viz. a great demand for statues of their gods. Architecture, as a fine art, made a slower progress. Proportions, upon which its elegance chiefly depends, cannot be accurately ascertained, but by an infinity of trials in great buildings. A model cannot be relied on; for a large and a small building, even of the same form, require different proportions.

FINE ARTS.

The term Fine Arts may be viewed as embracing all those arts in which the powers of imitation or invention are exerted, chiefly with a view to the production of pleasure by the immediate impression which they make on the mind. But the phrase has of late, we think, been restricted to a narrower and more technical signification; namely, to painting, sculpture, engraving, and architecture, which appeal to the eye as the medium of pleasure; and, by way of eminence, to the two first of these arts. In the following observations we shall adopt this limited sense of the term; and shall endeavour to develope the principles upon which the great masters have proceeded, and also to inquire, in a more particular manner, into the state and prospects of these arts in this country.

The great works of art at present extant, and which may be regarded as models of perfection in their several kinds, are the remains of classic art, consisting chiefly of sculpture—the pictures of the celebrated Italian masters—those of the old German and the Dutch and Flemish schools—to which we may add the comic productions of our own countryman Hogarth. These all stand unrivalled in the history of art; and they owe their pre-eminence and perfection to one and the same principle,—*the immediate imitation of nature.* This principle predominated equally in the classical forms of the antique and in the grotesque figures of Hogarth: the perfection of art in each arose from the truth and identity of the imitation with the reality; the difference was in the subjects—there was none in the mode of imitation. Yet the advocates for the *ideal system of art* would persuade their disciples, that the difference between Hogarth and the antique does not consist in the different forms of nature which they imitated, but in this, that the one is like and the other unlike nature. This is an error the most detrimental perhaps of all others, both to the theory and practice of art. As, however, the prejudice is very strong and general, and supported by the highest authority, it will be necessary to go somewhat elaborately into the question in order to produce an impression on the other side.

What has given rise to the common notion of the *ideal*, as something quite distinct from *actual* nature, is probably the perfection of the Greek statues. Not seeing among ourselves any thing to correspond in beauty and grandeur, either with the features or form of the limbs in these exquisite remains of antiquity, it was an obvious, but a superficial conclusion, that they must have been created from the idea existing in the artist's mind, and could not have been copied from any thing existing in nature. The contrary, however, is the fact. The general form, both of the face and figure, which we observe in the old statues, is not an ideal abstraction, is not a fanciful invention of the sculptor, but is as completely local and national (though it happens to be more beautiful) as the figures on a Chinese screen, or a copperplate engraving of a negro chieftain in a book of travels. It will not be denied that there is a difference of physiognomy as well as of complexion in different races of men. The Greek form appears to have been naturally beautiful, and they had, besides, every advantage of climate, of dress, of exercise, and modes of life to improve it. The artist had also every facility afforded him in the study and knowledge of the human form; and their religious and public institutions gave him every encouragement in the prosecution of this art. All these causes contributed to the perfection of these noble productions; but we should be inclined principally to attribute the superior symmetry of form common to the Greek statues, in the first place, to the superior symmetry of the models in nature; and in the second, to the more constant opportunities for studying them. If we allow, also, for the superior genius of the people, we shall not be wrong; but this superiority consisted in their peculiar susceptibility to the impres-

sions of what is beautiful and grand in nature. It may be thought an objection to what has just been said, that the antique figures of animals, &c., are as fine, and proceed on the same principles, as their statues of gods or men. But all that follows from this seems to be, that their art had been perfected in the study of the human form, the test and proof of power and skill; and was then transferred easily to the general imitation of all other objects, according to their true characters, proportions, and appearances. As a confirmation of these remarks, the antique portraits of individuals were often superior even to the personifications of their gods. We think that no unprejudiced spectator of real taste can hesitate for a moment in preferring the head of the Antinous, for example, to that of the Apollo. And in general it may be laid down as a rule, that the most perfect of the antiques are the most simple,—those which affect the least action, or violence of passion,—which repose the most on natural beauty of form, and a certain expression of sweetness and dignity, that is, which remain most nearly in that state in which they could be copied from nature without straining the limbs or features of the individual, or racking the invention of the artist. This tendency of Greek art to repose has indeed been reproached with insipidity by those who had not a true feeling of beauty and sentiment. We, however, prefer these models of habitual grace or internal grandeur to the violent distortions of suffering in the Laocoon, or even to the supercilious air of the Apollo. The Niobe, more than any other antique head, combines truth and beauty with deep passion. But here the passion is fixed, intense, habitual;—it is not a sudden or violent gesticulation, but a settled mould of features; the grief it expresses is such as might almost turn the human countenance itself *into marble!*

In general, then, we would be understood to maintain, that the beauty and grandeur so much admired in the Greek statues were not a voluntary fiction of the brain of the artist, but existed substantially in the forms from which they were copied, and by which the artist was surrounded. A striking authority in support of these observations, which has in some measure been lately discovered, is to be found in the *Elgin marbles*, taken from the Acropolis at Athens, and now universally admitted to be the work of Phidias. The process of fastidious refinement and indefinite abstraction is certainly not visible there. The figures have all the ease, the simplicity, and variety, of individual nature. Even the details of the subordinate parts, the loose hanging folds in the skin, the veins under the belly or on the sides of the horses, more or less swelled as the animal is more or less in action, are given with scrupulous exactness. This is true nature and true art. In a word, these invaluable remains of antiquity are precisely like casts taken from life. The *ideal* is not the preference of that which exists only in the mind to that which exists in nature; but the preference of that which is fine in nature to that which is less so. There is nothing fine in art but what is taken almost immediately, and, as it were, in the mass, from what is finer in nature. Where there have been the finest models in nature, there have been the finest works of art.

As the Greek statues were copied from Greek forms, so Raphael's expressions were taken from Italian faces; and we have heard it remarked, that the women in the streets at Rome seem to have walked out of his pictures in the Vatican.

Sir Joshua Reynolds constantly refers to Raphael as the highest example in modern times (at least with one exception) of the grand or ideal style; and yet he makes the essence of that style to consist in the embodying of an abstract or general idea, formed in the mind of the artist by rejecting the peculiarities of individuals, and retaining only what is common to the species. Nothing can be more inconsistent than the style of Raphael with this definition. In his Cartoons, and in his groupes in the Vatican, there is hardly a face or figure which is any thing more than fine individual nature finely disposed and copied. The painter Barry, who could not be suspected of prejudice on this side of the question, speaks thus of them: "In Raphael's pictures (at the Vatican) of the *Dispute of the Sacrament*, and the *School of Athens*, one sees all the heads to be entirely copied from particular characters in nature, nearly proper for the persons and situations which he adapts them to; and he seems to me only to add and take away what may answer his purpose in little parts, features, &c.; conceiving, while he had the head before him, ideal characters and expressions, which he adapts these features and peculiarities of face to. This attention to the particulars which distinguish all the different faces, persons, and characters, the one from the other, gives his pictures quite the verity and unaffected dignity of nature, which stamp the distinguishing differences betwixt one man's face and body and another's."

If any thing is wanting to the conclusiveness of this testimony, it is only to look at the pictures themselves; particularly the *Miracle of the Conversion*, and the *Assembly of Saints*, which are little else than a collection of divine portraits, in natural and expressive attitudes, full of the loftiest thought and feeling, and as varied as they are fine. It is this reliance on the power of nature which has produced those masterpieces by the prince of painters, in which expression is all in all;—where one spirit—that of truth—pervades every part, brings down heaven to earth, mingles cardinals and popes with angels and apostles,—and yet blends and harmonizes the whole by the true touches and intense feeling of what is beautiful and grand in nature. It is no wonder that Sir Joshua, when he first saw Raphael's pictures in the Vatican, was at a loss to discover any great excellence in them, if he was looking out for his theory of the *ideal*,—of neutral character and middle forms.

There is more an appearance of abstract grandeur of form in Michael Angelo. He has followed up, has enforced, and expanded, as it were, a preconceived idea, till he sometimes seems to tread on the verge of caricature. His forms, however, are not *middle*, but *extreme* forms, massy, gigantic, supernatural. They convey the idea of the greatest size and strength in the figure, and in all the parts of the figure. Every muscle is swollen and turgid. This tendency to exaggeration would have been avoided if Michael Angelo had recurred more constantly to nature, and had proceeded less on a scientific knowledge of the structure of the human body; for science gives only the positive form of the different parts, which the imagination may afterwards magnify as it pleases; but it is nature alone which combines them with perfect truth and delicacy, in all the varieties of motion and expression. It is fortunate that we can refer, in illustration of our doctrine, to the fragment of the Theseus in the British Museum, which shows the possibility of uniting the grand and natural style in the highest degree. The form of the limbs, as affected by pressure or action, and the general sway of the body, are preserved with the most consummate mastery. We should prefer this statue as a model for forming the style of the student to the Apollo, which strikes us as having something of a theatrical appearance; or to the Hercules, in which there is an ostentatious and over-laboured display of anatomy. This last figure is so overloaded with sinews, that it has been suggested as a doubt, whether, if life could be put into it, it would be able to move. Grandeur of conception, truth of nature, and pu-

rity of taste, seem to have been at their height when the masterpieces which adorned the Temple of Minerva at Athens, of which we have only these imperfect fragments, were produced. Compared with these, the later Greek statues display a more elaborate workmanship, more of the artifices of style. The several parts are more uniformly balanced, made more to tally like modern periods; each muscle is more equally brought out, and more highly finished as a part, but not with the same subordination of each part to the whole. If some of these wonderful productions have a fault, it is the want of that entire and naked simplicity which pervades the whole of the *Elgin marbles*.

Works of the Grecian and Italian artists.

Having spoken here of the Greek statues, and of the works of Raphael and Michael Angelo, as far as relates to the imitation of nature, we shall attempt to point out, to the best of our ability, and as concisely as possible, what we conceive to be their general and characteristic excellences. The ancients excelled in beauty of form; Michael Angelo in grandeur of conception; Raphael in expression. In Raphael's faces, particularly his women, the expression is very superior to the form; in the ancient statues the form is the principal thing. The interest which the latter excite is in a manner external; it depends on a certain grace and lightness of appearance, joined with exquisite symmetry and refined susceptibility to voluptuous emotions; but there is in general a want of pathos. In their looks we do not read the workings of the heart; by their beauty they seem raised above the sufferings of humanity; by their beauty they are deified. The pathos which they exhibit is rather that of present and physical distress, than of deep internal sentiment. What has been remarked of Lionardo da Vinci, is also true of Raphael, that there is an angelic sweetness and tenderness in his faces, in which human frailty and passion are purified by the sanctity of religion. The ancient statues are finer objects for the eye to contemplate; they represent a more perfect race of physical beings, but we have little sympathy with them. In Raphael, all our natural sensibilities are heightened and refined by the sentiments of faith and hope, pointing mysteriously to the interests of another world. The same intensity of passion appears also to distinguish Raphael from Michael Angelo. Michael Angelo's forms are grander, but they are not so informed with expression. Raphael's, however ordinary in themselves, are full of expression, " even to o'erflowing;" every nerve and muscle is impregnated with feeling,—bursting with meaning. In Michael Angelo, on the contrary, the powers of body and mind appear superior to any events that can happen to them; the capacity of thought and feeling is never full, never strained or tasked to the extremity of what it will bear. All is in a lofty repose and solitary grandeur, which no human interest can shake or disturb. It has been said that Michael Angelo painted *man*, and Raphael *men*; that the one was an epic, the other a dramatic painter. But the distinction we have stated is, perhaps, truer and more intelligible, viz., that the one aimed at greater dignity of form, and the other gave greater force and refinement of expression. Michael Angelo, in fact, formed his ideas on classic art, in favour of which an enthusiastic feeling had arisen in his time, many of the finest specimens of the works of the ancients having been then first brought to light; his style, therefore, is based very much on sculpture, and is characterized by grandeur and severity—nevertheless his works possess much that is picturesque. The whole figure of his *Jeremiah* droops and hangs down like a majestic tree surcharged with showers. His drawing of the human form has the characteristic freedom and boldness of Titian's landscapes.

After Michael Angelo and Raphael, there is no doubt that Lionardo da Vinci and Coreggio are the two painters, in modern times, who have carried historical expression to the highest ideal perfection; and yet it is equally certain that their heads are carefully copied from faces and expressions in nature. Lionardo excelled principally in his women and children. We find, in his female heads, a peculiar charm of expression; a character of natural sweetness and tender playfulness, mixed up with the pride of conscious intellect and the graceful reserve of personal dignity. He blends purity with voluptuousness; and the expression of his women is equally characteristic of " the mistress or the saint." His pictures are worked up to the height of the idea he had conceived, with an elaborate felicity; but this idea was evidently first suggested, and afterwards religiously compared with nature. This was his excellence. His fault is, that his style of execution is too mathematical; that is, his pencil does not follow the graceful variety of the details of objects, but substitutes certain refined gradations, both of form and colour, producing equal changes in equal distances, with a mechanical uniformity. Lionardo was a man of profound learning as well as genius, and perhaps transferred too much of the formality of science to his favourite art.

The masterpieces of Coreggio have the same identity with nature, the same stamp of truth. He has indeed given to his pictures the utmost softness and refinement of outline and expression; but this idea, at which he constantly aimed, is filled up with all the details and varieties which such heads would have in nature. So far from any thing like a naked abstract idea, or middle form, the *individuality* of his faces has something peculiar in it, even approaching the grotesque. He has endeavoured to impress habitually on the countenance those undulating outlines which rapture or tenderness leave there, and has chosen for this purpose those forms and proportions which most obviously assisted his design.

As to the colouring of Coreggio, it is nature itself. Not only is the general tone perfectly true, but every speck and particle is varied in colour, in relief, in texture, with a care, a felicity, and an effect, which is almost magical. His light and shade are equally admirable. No one else, perhaps, ever gave the same harmony and roundness to his compositions. So true are his shadows,—equally free from coldness, opacity, or false glare;—so clear, so broken, so airy, and yet so deep, that if you hold your hand so as to cast a shadow on any part of the flesh which is in the light, this part, so shaded, will present exactly the same appearance which the painter has given to the shadowed part of the picture. Coreggio, indeed, possessed a greater variety of excellences in the different departments of his art than any other painter; and yet it is remarkable, that the impression which his pictures leave upon the mind of the common spectator is monotonous and comparatively feeble. His style is in some degree mannered and confined. For instance, he is without the force, passion, and grandeur of Raphael, who, however, possessed his softness of expression, but of expression only; and in colour, in light and shade, and some other qualities, was perhaps not equal to Coreggio. We may, perhaps, solve this apparent contradiction by saying, that he applied the power of his mind to a greater variety of objects than others; but that this power was still of the same character; consisting in a certain exquisite sense of the harmonious, the soft and graceful in form, colour, and sentiment, but with a deficiency of strength, and a tendency to effeminacy in all these.

It was at one time the fashion after Raphael and Coreggio to mention Guido, whose female faces are exceedingly beautiful and ideal, but altogether commonplace and vapid compared with those of Raphael or Coreggio; and

for no other reason but that the general idea they convey is not enriched and strengthened by an intense contemplation of nature. For the same reason, we can conceive nothing more unlike the antique than the figures of Nicholas Poussin, except as to the preservation of the costume; and it is perhaps chiefly owing to the habit of studying his art at second-hand, or by means of scientific rules, that the great merits of that able painter, whose understanding and genius are unquestionable, are confined to his choice of subjects for his pictures, and his manner of telling the story. His landscapes, which he probably took from nature, are superior as paintings to his historical pieces. The faces of Poussin want natural expression, as his figures want grace; but the back-grounds of his historical compositions can scarcely be surpassed. In his *Plague of Athens*, the very buildings seem stiff with horror. His giants, seated on the top of their fabled mountains, and playing on their Pan pipes, are as familiar and natural as if they were the ordinary inhabitants of the scene. The finest of his landscapes is his picture of the *Deluge*. The sun is just seen, wan and drooping in his course. The sky is bowed down with a weight of waters, and heaven and earth seem mingling together.

Titian is at the head of the Venetian school. He is the first of all colourists. In delicacy and purity Coreggio is equal to him, but his colouring has not the same warmth and gusto in it. Titian's flesh-colour partakes of the glowing nature of the climate, and of the luxuriousness of the manners of his country. He represents objects not through a merely lucid medium, but as if tinged with a golden light. Yet it is wonderful in how low a tone of local colouring his pictures are painted,—how rigidly his means are husbanded. His most gorgeous effects are produced, not less by keeping down than by heightening his colours; the fineness of his gradations adds to their variety and force; and, with him, truth is the same thing as splendour. Every thing is done by the severity of his eye, by the patience of his touch. He is enabled to keep pace with nature by never hurrying on before her; and as he forms the broadest masses out of innumerable varying parts and minute strokes of the pencil, so he unites and harmonizes the strongest contrasts by the most imperceptible transitions. Every distinction is relieved and broken by some other intermediate distinction, like half-notes in music; and yet all this accumulation of endless variety is so managed as only to produce the majestic simplicity of nature, so that to a common eye there is nothing extraordinary in his pictures, any more than in nature itself. It is, we believe, owing to what has been here stated, that Titian is, of all painters, at once the easiest and the most difficult to copy. He is the most difficult to copy perfectly, for the artifice of his colouring and execution is hid in its apparent simplicity; and yet the knowledge of nature, and the arrangement of the forms and masses in his pictures, are so masterly, that any copy made from them, even the rudest outline or sketch, can hardly fail to have a look of high art. Because he was the greatest colourist in the world, this, which was his most prominent, has, for shortness, been considered as his only excellence; and he has been said to have been ignorant of drawing. What he was, generally speaking, deficient in, was invention or composition, though even this appears to have been more from habit than want of power; but his drawing of actual forms, where they were not to be put into momentary action, or adapted to a particular expression, was as fine as possible. His drawing of the forms of inanimate objects is unrivalled. His trees have a marked character and physiognomy of their own, and exhibit an appearance of strength or flexibility, solidity or lightness, as if they were endued with conscious power and purposes. Character was another excellence which Titian possessed in the highest degree. It is scarcely speaking too highly of his portraits to say, that they have as much expression, that is, convey as fine an idea of intellect and feeling, as the historical heads of Raphael. The chief difference appears to be, that the expression in Raphael is more imaginary and contemplative, and in Titian more personal and constitutional. The heads of the one seem thinking more of some event or subject, those of the other to be thinking more of themselves. In the portraits of Titian, as might be expected, the Italian character always predominates; there is a look of piercing sagacity, of commanding intellect, of acute sensibility, which it would be in vain to seek for in any other portraits. The daring spirit and irritable passions of the age and country are distinctly stamped upon their countenances, and can be as little mistaken as the costume which they wear. The portraits of Raphael, though full of profound thought and feeling, have more of common humanity about them. Titian's portraits are the most historical that ever were painted; and they are so for this reason, that they have most consistency of form and expression. His portraits of Hippolito de' Medici, and of a young Neapolitan nobleman, lately in the gallery of the Louvre, are a striking contrast in this respect. All the lines of the face in the one, the eye-brows, the nose, the corners of the mouth, the contour of the face, present the same sharp angles, the same acute, edgy, contracted, violent expression. The other portrait has the finest expansion of feature and outline, and conveys the most exquisite idea possible of mild, thoughtful sentiment. The consistency of the expression constitutes as great a charm in Titian's portraits as the harmony of the colouring. The similarity sometimes objected to his heads is partly national, and partly arises from the class of persons whom he painted. He painted only Italians; and in his time it rarely happened that any but persons of the highest rank, senators or cardinals, sat for their pictures. The similarity of costume of the dress, the beard, &c. also adds to the similarity of their appearance. It adds at the same time to their picturesque effect; and the alteration in this respect is one circumstance among others that has been injurious, not to say fatal, to modern art. This observation is not confined to portrait; for the hired dresses with which our historical painters clothe their figures sit no more easily on the imagination of the artist, than they do gracefully on the lay-figures over which they are thrown.

Giorgione, Paul Veronese, and Tintoret, are the remaining great names of the Venetian school. Their excellence consisted in bold, masterly and striking imitation of nature. Giorgione takes the first place among them; for he was the fellow-pupil and rival of Titian, whereas the others were only his disciples. His works, besides, are highly valued for their grandeur and dignity and for their poetical treatment, generally involving some deep allegorical meaning. The Caraccis, Domenichino, Guido, Guercino, and Albani, who established, after the decline of Italian art, what is generally styled the Bolognese school, formed themselves on the principle of combining the excellences of the Roman and Venetian painters; they flourished for a time, but at last degenerated into absolute insignificance, in proportion as they departed from nature, or the great masters who had copied her, to mould their works on academic rules, and the phantoms of abstract perfection.

Flemish and Dutch painters.

Rubens is the prince of the Flemish painters. Of all the great painters, he is perhaps the most artificial,—the one who painted most from his own imagination,—and, what was almost the inevitable consequence, the most of a mannerist. He had neither the Greek forms to study

from, nor the Roman expression, nor the high character, picturesque costume, and sun-burnt hues which the Venetian painters had immediately before them. He took, however, what circumstances presented to him,—a fresher and more blooming tone of complexion, arising from moister air and a colder climate. To this he added the congenial splendour of reflected lights and shadows cast from rich drapery; and he made what amends he could for the want of expression, by the richness of his compositions, and the fantastic variety of his allegorical groups. Both his colouring and his drawing were, however, ideal exaggerations. But both had particular qualities of the highest value. He has given to his flesh greater transparency and freshness than any other painter; and this excellence he had from nature. One of the finest instances will be found in his *Peasant Family going to Market*, in which the figures have all the bloom of health upon their countenances; and the very air of the surrounding landscape strikes sharp and wholesome on the sense. Rubens had another excellence; he has given all that relates to the expression of motion in his allegorical figures, in his children, his animals, even in his trees, to a degree which no one else has equalled, or indeed approached. His drawing is often deficient in proportion, in knowledge, and in elegance, but it is always picturesque. The drawing of N. Poussin, on the contrary, which has been much cried up, is merely learned and anatomical: he has a knowledge of the structure and measurements of the human body, but very little feeling of the grand, or beautiful, or striking in form. All Rubens' forms have ease, freedom, and excessive elasticity. In the grotesque style of history,—as in the groups of satyrs, nymphs, bacchanals, and animals, where striking contrasts of form are combined with every kind of rapid and irregular movement,—he has not a rival. Witness his Silenus at Blenheim, where the lines seem drunk and staggering; and his procession of Cupids riding on animals at Whitehall, with that adventurous leader of the infantine crew, who, with a spear, is urging a lion, on which he is mounted, over the edge of the world; for beyond we only see a precipice of clouds and sky. Rubens' power of expressing motion perhaps arose from the facility of his pencil, and his habitually trusting a good deal to memory and imagination in his compositions; for this quality can be given in no other way. It is to be regretted that he so seldom painted portraits, as those he executed (and in the gallery at Munich there are some fine specimens) possess very high qualities. His landscapes are often delightful, being generally truthful representations of Flemish scenery.

It remains to speak of Vandyck and Rembrandt, the one the disciple of Rubens, the other the entire founder of his own school. It is not possible for two painters to be more opposite. The characteristic merits of the former are very happily summed up in a single line of a poetical critic, where he speaks of "The soft precision of the clear Vandyck."

The general object of this analysis of the works of the great masters has been to show that their pre-eminence has constantly depended, not on the creation of a fantastic, abstract excellence, existing nowhere but in their own minds, but in their selecting and embodying some one view of nature, which came immediately under their habitual observation, and which their particular genius led them to study and imitate with success. This is certainly the case with Vandyck. His portraits, mostly of English women, in the collection in the Louvre, have a cool refreshing air about them, a look of simplicity and modesty even in the very tone, which forms a fine contrast to the voluptuous glow and mellow golden lustre of Titian's Italian women. There is a quality of flesh-colour in Vandyck which is to be found in no other painter, and which exactly conveys the idea of the soft, smooth, sliding, continuous, delicately varied surface of the skin. The objects in his pictures have the least possible difference of light and shade, and are presented to the eye without passing through any indirect medium. It is this extreme purity and silvery clearness of tone, together with the facility and precision of his particular forms, and a certain air of fashionable elegance, characteristic of the age in which he flourished, that places Vandyck in the first rank of portrait painters.

Rembrandt is peculiarly distinguished by the extreme originality of his style. He may be said to have created a medium of his own, through which he saw all objects. He was the grossest and the least vulgar, that is to say, the least common-place in his grossness, of all men. He was the most downright, the least fastidious of the imitators of nature. He took any object, he cared not what, how mean soever in form, colour, and expression; and from the light and shade which he threw upon it, it came out gorgeous from his hands. As Vandyck made use of the smallest contrasts of light and shade, and painted as if in the open air, Rembrandt used the most violent and abrupt contrasts in this respect, and painted his objects as if in a dungeon. His pictures may be said to be "bright with excessive darkness." His vision had acquired a lynx-eyed sharpness from the artificial obscurity to which he had accustomed himself. "Mystery and silence hung upon his pencil." Yet he could pass rapidly from one extreme to another, and dip his colours with equal success in the gloom of night or in the blaze of the noon-day sun. In surrounding different objects with a medium of imagination, solemn or dazzling, he was a true poet; in all the rest he was a mere painter, but a painter of no common stamp. The powers of his hand were equal to those of his eye; and indeed he could not have attempted the subjects he did, without an execution as masterly as his knowledge was profound. His colours are sometimes dropped in lumps on the canvass; at other times they are laid on as smooth as glass; and he not unfrequently painted with the handle of his brush. He had an eye for all objects as far as he had seen them. His history and landscapes are equally fine in their way. His landscapes we could look at for ever, though there is nothing in them. But "they are of the earth, earthy." It seems as if he had dug them out of nature. Every thing is so true, so real, so full of all the feelings and associations which the eye can suggest to the other senses, that we immediately take as strong an affection to them as if they were our home—the very place where we were brought up. No length of time could add to the intensity of the impression they convey. Rembrandt is the least classical and the most romantic of all painters. His *Jacob's Ladder* is more like a dream than any other picture that ever was painted. The figure of Jacob himself is thrown in one corner of the picture like a bundle of clothes, while the angels hover above the darkness in the shape of airy wings.

It would be needless to prove that the generality of the Dutch painters copied from actual objects. They have become almost a bye-word for carrying this principle into its abuse, by copying every thing they saw, and having no choice or preference of one thing to another, unless that they preferred that which was most obvious and common. We forgive them. They perhaps did better in faithfully and skilfully imitating what they had seen, than in imagining what they had not seen. Their pictures at least show that there is nothing in nature, however mean or trivial, that has not its beauty, and some interest belonging to it, if truly represented. We prefer Vangoyen's views on the borders of a canal, the yellow-

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tufted bank and passing sail, or Ruysdael's woods and sparkling water-falls, to the most classical or epic compositions which they could have invented out of nothing; and we think that Teniers' boors, old women, and children, are very superior to the little carved ivory Venuses in the pictures of Vanderneer; just as we think Hogarth's *Marriage à la Mode* is better than his *Sigismunda*, or, as Wilkie's *Card-Players* is better than his *Alfred*. We should not assuredly prefer a *Dutch Fair* by Teniers to a *Cartoon* by Raphael; but we suspect we should prefer a *Dutch Fair* by Teniers to a *Cartoon* by the same master; or we should prefer truth and nature in the simplest dress, to affectation and inanity in the most pompous disguise. Whatever is genuine in art must proceed from the impulse of nature and individual genius.

French and Spanish painters.

In the French school there are but two names of high and established reputation, N. Poussin and Claude Lorraine. Of the former we have already spoken; of the latter we shall give our opinion when we come to speak of our own Wilson. We ought not to pass over the names of Murillo and Velasquez, those admirable Spanish painters. It is difficult to characterize their peculiar excellences as distinct from those of the Italian and Dutch schools. They may be said to hold a middle rank between the painters of mind and body. They express not so much thought and sentiment, nor yet the mere exterior, as the life and spirit of the man. Murillo is probably at the head of that class of painters who have treated subjects of common life. After making the colours on the canvass feel and think, the next best thing is to make them breathe and live. But there is in Murillo's pictures of this kind a look of real life, a cordial flow of native animal spirits, which we find nowhere else. We might here refer particularly to his picture of the *Two Spanish Beggar Boys*, in the collection at Dulwich College, which cannot easily be forgotten by those who have ever seen it.

Progress of art in Britain.

We come now to treat of the progress of art in Britain. We shall speak first of Hogarth, both as he is the first name in the order of time that we have to boast of, and as he is the greatest comic painter of any age or country. His pictures are not imitations of still life, or mere transcripts of incidental scenes or customs; but powerful moral satires, exposing vice and folly in their most ludicrous points of view, and, with a profound insight into the weak sides of character and manners, in all their tendencies, combinations, and contrasts. There is not a single picture of his, containing a representation of merely natural or domestic scenery. His object is not so much "to hold the mirror up to nature," as "to show vice her own feature, scorn her own image." Folly is there seen at the height—the moon is at the full—it is the very error of the time. There is a perpetual collision of eccentricities, a tilt and tournament of absurdities, pampered into all sorts of affectation, airy, extravagant, and ostentatious! Yet he is as little a caricaturist as he is a painter of still life. Criticism has not done him justice, though public opinion has. His works have received a sanction which it would be vain to dispute, in the universal delight and admiration with which they have been regarded, from their first appearance to the present moment. If the quantity of amusement, or of matter for reflection, which they have afforded, is that by which we are to judge of precedence among the intellectual benefactors of mankind, there are perhaps few persons who can put in a stronger claim to our gratitude than Hogarth. The wonderful knowledge which he possessed of human life and manners is only to be surpassed (if it can be) by the powers of invention with which he has arranged his materials, and by the mastery of execution with which he has embodied and made tangible the very thoughts and passing movements of the mind. Some persons object to the style of Hogarth's pictures, or the class to which they belong. First, Hogarth belongs to no class, or, if he belongs to any, it is to the same class as Fielding, Smollett, Vanbrugh, and Molière. Besides, the merit of his pictures does not depend on the nature of his subjects, but on the knowledge displayed of them, on the number of ideas, on the fund of observation and amusement contained in them. Make what deductions you please for the vulgarity of the subjects—yet in the research, the profundity, the absolute truth and precision of the delineation of character,—in the invention of incident, in wit and humour, in life and motion, in everlasting variety and originality,—they never have been, and probably never will be, surpassed. They stimulate the faculties, as well as amuse them. "Other pictures we see, Hogarth's we read!"[1]

There is one error which has been frequently entertained on this subject, and which we wish to correct, namely, that Hogarth's genius was confined to the imitation of the coarse humours and broad farce of the lowest life. But he excelled quite as much in exhibiting the vices, the folly, and frivolity of the fashionable manners of his time. His fine ladies do not yield the palm of ridicule to his waiting-maids, and his lords and his porters are on a very respectable footing of equality. He is quite at home, either in St Giles's or St James's. There is no want, for example, in his *Marriage à la Mode*, or his *Taste in High Life*, of affectation verging into idiotcy, or of languid sensibility that might

Die of a rose in aromatic pain.

Many of Hogarth's characters would form admirable illustrations of Pope's Satires, who was contemporary with him. In short, Hogarth was a painter of real, not of low life. He was, as we have said, a satirist, and consequently his pencil did not dwell on the grand and beautiful, but it glanced with equal success at the absurdities and peculiarities of high or low life, "of the great vulgar and the small."

To this it must be added, that he was as great a master of passion as of humour. He succeeded in low tragedy as much as in low or genteel comedy, and had an absolute power in moving the affections and rending the hearts of the spectators, by depicting the effects of the most dreadful calamities of human life on common minds and common countenances. Of this the *Rake's Progress*, particularly the bedlam scene, and many others, are unanswerable proofs. Hogarth's merits as a mere artist are not confined to his prints. In general, indeed, this is the case. But when he chose to take pains, he could add the delicacies of execution and colouring in the highest degree to those of character and composition; as is evident in his series of pictures, all equally well painted, of the *Marriage à la Mode*.

We shall next speak of Wilson, whose pictures may be divided into three classes,—his Italian landscapes, or imitations of the manner of Claude,—his copies of English scenery,—and his historical compositions. The first of these are, in our opinion, by much the best; and we appeal, in support of this opinion, to the *Apollo and the Seasons*, and to the *Phaeton*. The figures are of course out of the question (these being as uncouth and slovenly as Claude's are insipid and finical); but the landscape in both pictures is delightful. In looking at them we breathe the air which the scene inspires, and feel the genius of the place present to us.

[1] See an admirable essay on the genius of Hogarth, by Charles Lamb, in a periodical work called *The Reflector*.

In general, Wilson's views of English scenery want almost everything that ought to recommend them. The subjects he has chosen are not well fitted for the landscape painter, and there is nothing in the execution to redeem them. Ill-shaped mountains, or great heaps of earth,—trees that grow against them without character or elegance—motionless waterfalls,—a want of relief, of transparency and distance, without the imposing grandeur of real magnitude (which it is scarcely within the province of art to give), are the chief features and defects of this class of his pictures.

His historical landscapes, his *Niobe, Celadon, and Amelia,* &c., do not, in our estimation, display either true taste or fine imagination, but are affected and violent exaggerations of clumsy common nature. They are made up mechanically of the same stock of materials,—an overhanging rock, bare shattered trees, black rolling clouds, and forked lightning. The figures in the most celebrated of these are not, like the children of Niobe, punished by the gods, but like a group of rustics crouching from a hail-storm. We agree with Sir Joshua Reynolds, that Wilson's mind was not, like N. Poussin's, sufficiently imbued with the knowledge of antiquity to transport the imagination 3000 years back, to give natural objects a sympathy with preternatural events, and to inform rocks, and trees, and mountains, with the presence of a God. To sum up his general character, we may observe, that, besides his excellence in aërial perspective, Wilson had great truth, harmony, and depth of local colouring. He had a fine feeling of the proportions and conduct of light and shade, and also an eye for graceful form, as far as regards the bold and varying outlines of indefinite objects, as may be seen in his foregrounds, &c., where the artist is not tied down to an imitation of characteristic and articulate forms. In his figures, trees, cattle, and in everything having a determinate and regular form, his pencil was not only deficient in accuracy of outline, but even in perspective and actual relief. His trees, in particular, frequently seem pasted on the canvas, like botanical specimens. In fine, we cannot subscribe to the opinion of those who assert that Wilson was superior to Claude as a man of genius; nor can we discern any other grounds for this opinion than what would lead to the general conclusion,—that the more slovenly the performance the finer the picture, and that that which is imperfect is superior to that which is perfect. It might be said, on the same principle, that the coarsest sign-painting is better than the reflection of a landscape in a mirror; and the objection that is sometimes made to the mere imitation of nature cannot be made to the landscapes of Claude, for in them the graces themselves have, with their own hands, assisted in selecting and disposing every object. Is the general effect in *his* pictures injured by the details? Is the truth inconsistent with the beauty of the imitation? Does the perpetual profusion of objects and scenery, all perfect in themselves, interfere with the simple grandeur and comprehensive magnificence of the whole? Does the precision with which a plant is marked in the foreground take away from the air-drawn distinctions of the blue glimmering horizon? Is there any want of that endless airy space, where the eye wanders at liberty under the open sky, explores distant objects, and returns back as from a delightful journey? There is no comparison between Claude and Wilson. Sir Joshua Reynolds used to say that there would be another Raphael before there would be another Claude. His landscapes have all that is exquisite and refined in art and nature. Everything is moulded into grace and harmony; and, at the touch of his pencil, shepherds with their flocks, temples and groves, and winding glades and scattered hamlets, rise up in never-ending succession, under the azure sky and the resplendent sun, while

> Universal Pan
> Knit with the graces, and the hours in dance,
> Leads on the eternal spring.——

Michael Angelo has left, in one of his sonnets, a fine apostrophe to the earliest poet of Italy:

> Fain would I, to be what our Dante was,
> Forego the happiest fortunes of mankind.

What landscape painter does not feel this of Claude.[1]

We have heard an anecdote connected with the reputation of Gainsborough's pictures, which rests on pretty good authority. Sir Joshua Reynolds, at one of the academy dinners, speaking of Gainsborough, said to a friend, "He is undoubtedly the best English landscape painter." "No," said Wilson, who overheard the conversation; "he is not the best landscape painter, but he is the best portrait painter in England." They were both wrong; but the story is creditable to the versatility of Gainsborough's talents.

Those of his portraits which we have seen are not in the first rank. They are, in a good measure, imitations of Vandyck, and have more an air of gentility than of nature. His landscapes are of two classes or periods, his early and his later pictures. The former are minute imitations of nature, or of painters who imitated nature, such as Ruysdael, &c., some of which have great truth and clearness. His later pictures are flimsy caricatures of Rubens, who himself carried inattention to the details to the utmost limit that it would bear. Many of Gainsborough's later landscapes may be compared to bad water-colour drawings, washed in by mechanical movements of the hand, without any communication with the eye. The truth seems to be, that Gainsborough found there was something wanting in his *early manner*, that is, something beyond the literal imitation of the details of natural objects; and he appears to have concluded rather hastily, that the way to arrive at that *something more* was to discard truth and nature altogether. His fame rests principally, at present, on his fancy pieces, cottage children, shepherd boys, &c. These have often great truth, great sweetness, and the subjects are often chosen with great felicity. We too often find, however, even in his happiest efforts, a consciousness in the turn of the limbs, and a pensive languor in the expression, which is not taken from nature. We think the gloss of art is never so ill bestowed as on such subjects, the essence of which is simplicity. It is, perhaps, the general fault of Gainsborough, that he presents us with an ideal common life, of which we have had a surfeit in poetry and romance. His subjects are softened and sentimentalized too much; it is not simple unaffected nature that we see, but nature sitting for her picture.

Our artist, we suspect, led the way to that masquerade style, which piques itself on giving the air of an Adonis to the driver of a hay cart, and models the features of a milkmaid on the principles of the antique. His *Woodman's Head* is admirable. Nor can too much praise be given to his *Shepherd Boy in a Storm*, in which the unconscious simplicity of the boy's expression, looking up with his hands folded and with timid wonder,—the noisy chattering of a magpie perched above,—and the rustling of the coming storm in the branches of the trees,—produce a most delightful and romantic impression on the mind.

Gainsborough was to be considered, perhaps, rather as a man of delicate taste, and of an elegant and feeling mind, than as a man of genius; as a lover of the art rather than an artist. He devoted himself to it with a view to amuse and soothe his mind, with the ease of a gentleman, not with

[1] Claude left sketches of all the pictures he had painted, in a book which he denominated *Liber Veritatis.* By reference to this he avoided repetitions of his subjects; and it has served in aftertimes to ascertain the originality of his reputed productions. On the back of these drawings he wrote the names of the individuals by whom the pictures were purchased. That volume is now in the possession of the Duke of Devonshire.

the severity of a professional student. He wished to make his pictures, like himself, amiable; but a too constant desire to please almost unavoidably leads to affectation and effeminacy. He wanted that vigour of intellect which perceives the beauty of truth; and thought that painting was to be gained, like other mistresses, by flattery and smiles. It was an error which we are disposed to forgive in one around whose memory, both as an artist and a man, many fond recollections, many vain regrets, must always linger.[1]

The authority of Sir Joshua Reynolds, both from his example and instructions, has had, and still continues to have, a considerable influence on the state of art in this country. That influence has been, on the whole, unquestionably beneficial in itself, as well as highly creditable to the rare talents and elegant mind of Sir Joshua; for it has raised the art of painting from the lowest state of degradation,—of dry, meagre, lifeless inanity,—to something at least respectable, and bearing an affinity to the rough strength and bold spirit of the national character. Whether the same implicit deference to his authority, which has helped to advance the art thus far, may not, among other causes, limit and retard its future progress,—whether there are not certain original errors, both in his principles and practice, which, the farther they are proceeded in, the farther they will lead us from the truth,—whether there is not a systematic bias from the right line, by which alone we can arrive at the goal of the highest perfection,—are questions well worth considering.

We shall begin with Sir Joshua's merits as an artist. There is one error which we wish to correct at setting out, because we think it important. There is not a greater or more unaccountable mistake than the supposition that Sir Joshua Reynolds owed his success or excellence in his profession to his having been the first who introduced into this country more general principles of the art, and who raised portrait to the dignity of history, from the low drudgery of copying the peculiarities, meannesses, and details of individual nature, which was all that had been attempted by his immediate predecessors. This is so far from being true, that the very reverse is the fact. If Sir Joshua did not give these details and peculiarities so much as might be wished, those who went before him did not give them at all. Those pretended general principles of the art, which, it is said, "alone give value and dignity to it," had been pushed to their extremest absurdity before his time; and it was in getting rid of the mechanical systematic monotony and *middle forms*, by the help of which Lely, Kneller, Hudson, the French painters, and others, carried on their manufactories of history and face painting, and in returning (as far as he did return) to the truth and force of individual nature, that the secret both of his fame and fortune lay. The pedantic servile race of artists whom Reynolds superseded had carried the abstract principle of improving on nature to such a degree of refinement that they left it out altogether, and confounded all the varieties and irregularities of form, feature, character, expression, or attitude, in the same artificial mould of fancied grace and fashionable insipidity. The portraits of Kneller, for example, seem all to have been turned in a machine; the eye-brows are arched as if by a compass, the mouth curled, and the chin dimpled; the head turned on one side, and the hands placed in the same affected position. The portraits of this mannerist, therefore, are as like one another as the dresses which were then in fashion, and have the same "dignity and value" as the full-bottomed wigs which graced their originals. The superiority of Reynolds consisted in his being varied and natural, instead of being artificial and uniform. The spirit, grace, or dignity, which he added to his portraits, he borrowed from nature, and not from the ambiguous quackery of rules. His feeling of truth and nature was too strong to permit him to adopt the unmeaning style of Kneller and Hudson; but his logical acuteness was not such as to enable him to detect the verbal fallacies and speculative absurdities which he had learned from Richardson and Coypel; and from some defects in his own practice, he was led to confound negligence with grandeur. But of this hereafter.

Sir Joshua Reynolds owed his vast superiority over his contemporaries to incessant practice and habitual attention to nature, to quick organic sensibility, to considerable power of observation, and still greater taste in perceiving and availing himself of those excellencies of others which lay within his own walk of art. We can by no means look upon Sir Joshua as having a claim to the first rank of genius. He would hardly have been a great painter if other greater painters had not lived before him. He would not have given a first impulse to the art; nor did he advance any part of it beyond the point where he found it. He did not present any new view of nature, nor is he to be placed in the same class with those who did. Even in colour, his pallet was spread for him by the old masters; and his eye imbibed its full perception of depth and harmony of tone from the Dutch and Venetian schools rather than from nature. His early pictures are poor and flimsy. He indeed learned to see the finer qualities of nature through the works of art, which he, perhaps, might never have discovered in nature itself. He became rich by the accumulation of borrowed wealth; and his genius was the offspring of taste. He combined and applied the materials of others to his own purpose with admirable success; he was an industrious compiler or skilful translator, not an original inventor, in art. The art would remain, in all its essential elements, just where it is if Sir Joshua had never lived. He has supplied the industry of future plagiarists with no new materials. But it has been well observed, that the value of every work of art, as well as the genius of the artist, depends not more on the degree of excellence than on the degree of originality displayed in it. Sir Joshua, however, was perhaps the most original imitator that ever appeared in the world; and the reason of this, in a great measure, was, that he was compelled to combine what he saw in art with what he saw in nature, which was constantly before him. The portrait painter is, in this respect, much less liable than the historical painter to deviate into the extremes of manner and affectation; for he cannot discard nature altogether under the excuse that *she only puts him out*. He must meet her face to face; and if he is not incorrigible, he will see something there that cannot fail to be of service to him. Another circumstance which must have been favourable to Sir Joshua was, that though not the originator *in point of time*, he was the first Englishman who transplanted the higher excellencies of his profession into his own country, and had the merit, if not of an inventor, of a reformer of the art. His mode of painting had the graces of novelty in the age and country in which he lived; and he had, therefore, all the stimulus to exertion which arose from the enthusiastic applause of his contemporaries, and from a desire to expand and refine the taste of the public.

To an eye for colour, and for effects of light and shade, Sir Joshua united a strong perception of individual character—a lively feeling of the quaint and grotesque in expression, and great mastery of execution. He had comparatively little knowledge of drawing, either as it regarded proportion or form. The beauty of some of his female faces and figures arises almost entirely from their softness and fleshiness. His pencil wanted firmness and precision. The expression, even of his best portraits, seldom implies either lofty or impassioned intellect or delicate sensibility. He

[1] The idea of the necessity of improving upon nature, and giving what was called a *flattering likeness*, was universal in this country seventy years ago, so that Gainsborough is not to be so much blamed for tampering with his subjects.

also wanted grace, if grace requires simplicity. The mere negation of stiffness and formality is not grace; for looseness and distortion are not grace. His favourite attitudes are not easy and natural, but the affectation of ease and nature. They are violent deviations from a right line. Many of the figures in his fancy pieces are placed in postures in which they could not remain for an instant without extreme difficulty and awkwardness. We might instance the *Girl Drawing with a Pencil*, and some others. His portraits are his best pictures. He had a selection of fine subjects, and the great advantage, as far as practice went, in painting a number of persons of every rank and description. Some of the finest and most interesting are those of Dr Johnson, Goldsmith (which is, however, too much a mere sketch), Baretti, Dr Burney, John Hunter, and the inimitable portrait of Bishop Newton. The elegant simplicity of character, expression, and drawing, preserved throughout the last picture, even to the attitude and mode of handling, discover the true genius of a painter. We also remember to have seen a print of Thomas Warton, than which nothing could be more characteristic or more natural. These were all Reynolds' intimate acquaintances, and it could not be said of them that they were men of "no mark or likelihood." Their traits had probably sunk deep into the artist's mind; he painted them as pure studies from nature, copying the real image existing before him, with all its known characteristic peculiarities; and, with as much wisdom as good-nature, sacrificing the graces on the altar of friendship. They are downright portraits and nothing more, and they are valuable in proportion. In his portraits of women, Sir Joshua had to contend with, and often to modify—and this, probably, was one of the reasons of his generalizing so much—the barbarous costume of his time, yet he has done so with such success, and imparted so much grace and elegance to to his portraits of ladies, that an accomplished writer (Lady Eastlake) has lately attempted to prove by reference to his portraits that the costume of Sir Joshua's day is preferable to that of any other period.

The arch simplicity of expression, and the grotesque character which he has given to the heads of his children, though striking and beautiful, are borrowed from Correggio, and are rather overdone. His *Puck* is the most masterly of all these; and the colouring, execution, and character are alike exquisite. The single figure of the *Infant Hercules* is also admirable. Many of those to which his friends have suggested historical titles are mere common portraits or casual studies. Thus, the *Infant Samuel* is an innocent little child saying its prayers at the bed's feet: it has nothing to do with the story of the Hebrew prophet. The same objection will apply to many of his fancy pieces and historical compositions. There is often no connection between the picture and the subject but the name. Even his celebrated Iphigenia, beautiful as she is, and prodigal of her charms, does not answer to the idea of the story. In drawing the naked figure, Sir Joshua's want of truth and firmness of outline became more apparent; and his mode of laying on his colours, which in the face and extremities was relieved and broken by the abrupt inequalities of surface and variety of tints in each part, produced a degree of heaviness and opacity in the larger masses of flesh-colour, which can, indeed, only be avoided by extreme delicacy or extreme lightness of execution.

Shall we speak the truth at once? In our opinion, Sir Joshua did not possess either that high imagination, or those strong feelings, without which no painter can become a poet in his art. His larger historical compositions have been generally allowed to be most liable to objection in a critical point of view. We shall not attempt to judge them by scientific or technical rules, but make one or two observations on the character and feeling displayed in them. The highest subject which Sir Joshua has attempted was the *Count Ugolino*, and it was, as might be expected from the circumstances, a total failure. He had, it seems, painted a study of an old beggar-man's head; and some person, who must have known as little of painting as of poetry, persuaded the unsuspecting artist that it was the exact expression of Dante's Count Ugolino, one of the most grand, terrific, and appalling characters in modern fiction. Reynolds, who knew nothing of the matter but what he was told, took his good fortune for granted, and only extended his canvass to admit the rest of the figures. The attitude and expression of Count Ugolino himself are what the artist intended them to be, till they were pampered into something else by the officious vanity of friends—those of a common mendicant at the corner of a street, waiting patiently for some charitable donation. The imagination of the painter took refuge in a parish workhouse, instead of ascending the steps of the Tower of Famine. The hero of Dante is a lofty, high-minded, and unprincipled Italian nobleman, who had betrayed his country to the enemy, and who, as a punishment for this crime, is shut up with his four sons in the dungeon of the citadel, where he shortly finds the doors barred against him, and food withheld. He in vain watches with eager feverish eye the opening of the door at the accustomed hour, and his looks turn to stone; his children one by one drop down dead at his feet; he is seized with blindness, and, in the agony of his despair, he gropes on his knees after them,

> ....Calling each by name
> For three days after they were dead.

Even in the other world he is represented with the same fierce, dauntless, unrelenting character, "gnawing the skull of his adversary, his fell repast." The subject of the *Laocoon* is scarcely equal to that described by Dante. The horror *there* is physical and momentary; in the other, the imagination fills up the long, obscure, dreary void of despair, and joins its unutterable pangs to the loud cries of nature. What is there in the picture to convey the ghastly horrors of the scene, or the mighty energy of soul with which they are borne? His picture of *Macbeth* is full of wild and grotesque images; and the apparatus of the witches contains a very elaborate and well-arranged inventory of dreadful objects. His Cardinal Beaufort is a fine display of rich mellow colouring; and there is something gentlemanly and Shakspearian in the king and the attendant nobleman. At the same time we think the expression of the cardinal himself is too much one of physical horror, a canine gnashing of the teeth, like a man strangled. This is not the best style of history. Mrs Siddons as the *Tragic Muse* is neither the tragic muse nor Mrs Siddons; and we have still stronger objections to *Garrick between Tragedy and Comedy*.

In his historical works in particular there is a striking similarity between Sir Joshua Reynolds' theory and his practice; and as each of these has been appealed to in support of the other, it is necessary that we should examine both. Sir Joshua's practice was generally confined to the illustration of that part of his theory which relates to the more immediate imitation of nature; and it is to what he says on this subject that we shall chiefly direct our observations at present.

He lays it down as a general and invariable rule, that "*the great style in art, and the most* PERFECT IMITATION OF NATURE, *consists in avoiding the details and peculiarities of particular objects.*" This sweeping principle he applies almost indiscriminately to *portrait, history,* and *landscape;* and he appears to have been led to the conclusion itself, from supposing the imitation of particulars to be inconsistent with general rule and effect. It appears to us that the highest perfection of the art depends, not on separating, but on uniting general truth and effect with individual distinctness and accuracy.

First, It is said that the great style in painting, as it relates to the immediate imitation of external nature, consists in avoiding the details of particular objects. It consists

neither in giving nor avoiding them, but in something quite different from both. Any one may avoid the details. So far there is no difference between the *Cartoons* and a common sign painting. Greatness consists in giving the larger masses and proportions with truth;—this does not prevent giving the smaller ones too. The utmost grandeur of outline, and the broadest masses of light and shade, are perfectly compatible with the utmost minuteness and delicacy of detail, as may be seen in nature. It is not, indeed, common to see both qualities combined in the imitations of nature, any more than the combination of other excellences; nor are we here saying to which the principal attention of the artist should be directed; but we deny that, considered in themselves, the absence of the one quality is necessary or sufficient to the production of the other.

If, for example, the form of the eye-brow is correctly given, it will be perfectly indifferent to the truth or grandeur of the design, whether it consists of one broad mark, or is composed of a number of hair-lines arranged in the same order. So, if the lights and shades are disposed in fine and large masses, the *breadth* of the picture, as it is called, cannot possibly be affected by the filling up of those masses with the details, that is, with the subordinate distinctions which appear in nature. The anatomical details in Michael Angelo, the ever-varying outline of Raphael, the perfect execution of the Greek statues, do not destroy their symmetry or dignity of form; and in the finest specimens of the composition of colour we may observe the largest masses combined with the greatest variety in the parts of which those masses are composed.

The *gross* style consists in giving no details, the *finical* in giving nothing else. Nature contains both large and small parts, both masses and details; and the same may be said of the most perfect works of art. The union of both kinds of excellence, of strength with delicacy, as far as the limits of human capacity and the shortness of human life would permit, is that which has established the reputation of the most successful imitators of nature. Farther, their most finished works are their best. The predominance, indeed, of either excellence in the best masters has varied according to their opinion of the relative value of these qualities,—the labour they had the time or the patience to bestow on their works,—the skill of the artist,—or the nature and extent of his subject. But if the rule here objected to, that the careful imitation of the parts injures the effect of the whole, be once admitted, slovenliness would become another name for genius, and the most unfinished performance be the best. That such has been the confused impression left on the mind by the perusal of Sir Joshua Reynolds' *Discourses*, is evident from the practice as well as conversation of many (even eminent) artists. The late Mr Opie proceeded entirely on this principle. He left many admirable studies of portraits, particularly in what relates to the disposition and effect of light and shade; but he never finished any of the parts, thinking them beneath the attention of a great artist. He went over the whole head the second day as he had done the first, and therefore made no progress. The picture at last, having neither the lightness of a sketch nor the accuracy of a finished work, looked coarse, laboured, and heavy. Titian is an excellent example of high finishing united with breadth. In him the details are engrafted on the most profound knowledge of effect, and attention to the character of what he represented. His pictures have the exact look of nature, the very tone and texture of flesh. The variety of his tints is blended into the greatest simplicity. There is a proper degree both of solidity and transparency. All the parts hang together; every stroke tells, and adds to the effect of the rest. Sir Joshua seems to deny that Titian finished much, and says that he produced, by two or three strokes of his pencil, effects which the most laborious copyist would in vain attempt to equal. It is true, he availed himself in some degree of what is called *execution*, to facilitate his imitation of the details and peculiarities of nature; but it was to facilitate, not to supersede it. There can be nothing more distinct than execution and daubing. Titian, however, made a very moderate, though a very admirable, use of this power; and those who copy his pictures will find that the simplicity is in the results, not in the details. To conclude our observations on this head, we will only add, that while the artist thinks there is anything to be done, either to the whole or to the parts of his picture, which can give it still more the look of nature, if he is willing to proceed, we would not advise him to desist. This rule is the more necessary to the young student, for he will be apt to relax in his attention as he grows older.

Secondly, With regard to the imitation of expression, we can hardly agree with Sir Joshua, that "the perfection of portrait painting consists in giving the general idea or character without the individual peculiarities." No doubt, if we were to choose between the general character and the peculiarities of feature, we ought to prefer the former. But they are so far from being incompatible with, that they are not without some difficulty distinguishable from, each other. There is a general look of the face, a predominant expression arising from the correspondence and connection of the different parts, which it is of the first and last importance to give, and without which no elaboration of detached parts, or marking of the peculiarities of single features, is worth anything; but which, at the same time, is not destroyed, but assisted, by the careful finishing, and still more by giving the exact outline, of each part.

Till within these few years it was on this point that the modern French and English schools differed, and, in our opinion, were both wrong. The English seemed generally to suppose, that if they only left out the subordinate parts, they were sure of the general result. The French, on the contrary, as erroneously imagined that, by attending successively to each separate part, they would infallibly arrive at a correct whole; not considering that, besides the parts, there is their relation to each other, and the general expression stamped upon them by the character of the individual, which to be seen must be felt; for it is demonstrable, that all character and expression, to be adequately represented, must be perceived by the mind, and not by the eye only. The French painters gave only lines and precise differences, the English only general masses and strong effects. But sounder ideas and a more correct practice now prevail in both countries.

Much has been said of *historical portrait;* and we have no objection to this phrase, if properly understood. The giving historical truth to a portrait means, then, the representing the individual under one consistent, probable, and striking view; or showing the different features, muscles, &c., in one action, and modified by one principle. A portrait thus painted may be said to be *historical;* that is, it carries internal evidence of truth and propriety with it; and the number of individual peculiarities, as long as they are true to nature, cannot lessen, but must add to, the strength of the general impression.

It might be shown, if there were room in this place, that Sir Joshua has constructed his theory of the *ideal* in art upon the same mistaken principle of the negation or abstraction of *particular nature.* The *ideal* is not a negative, but a positive thing. The leaving out the details or peculiarities of an individual face does not make it one jot more ideal. To paint history, is to paint nature as answering to a general, predominant, or preconceived idea in the mind, of strength, beauty, action, passion, thought, &c.: but the way to do this is not to leave out the details, but to incorporate the general idea with the details; that is, to show the same expression actuating and modifying every movement of the muscles, and the same character preserved consistently through every part of the body. Grandeur does not consist in omitting the parts, but in connecting all the

parts into a whole, and in giving their combined and varied action: abstract truth or ideal perfection does not consist in rejecting the peculiarities of form, but in rejecting all those which are not consistent with the character intended to be given, and in following up the same *general idea* of softness, voluptuousness, strength, activity, or any combination of these, through every ramification of the frame. But these modifications of form or expression can only be learnt from nature, and therefore the perfection of art must always be sought in nature. The ideal properly applies as much to the *idea* of ugliness, weakness, folly, meanness, vice, as of beauty, strength, wisdom, magnanimity, or virtue. The antique heads of fauns and satyrs, of Pan or Silenus, are quite as ideal as those of the Apollo or Bacchus; and Hogarth adhered to an idea of humour in his faces, as Raphael did to an idea of sentiment. But Raphael found the character of sentiment in nature as much as Hogarth did that of humour, otherwise neither of them would have given one or the other with such perfect truth, purity, force, and keeping. Sir Joshua Reynolds' *ideal*, as consisting in a mere negation of individuality, bears just the same relation to real beauty or grandeur as caricature does to true comic character.

Writers on art have long been in the habit of complaining that the English are hitherto without any painter of serious historical subjects, who can be placed in the first rank of genius;—that although many of the pictures of modern artists have shown a capacity for correct and happy delineation of actual objects and domestic incidents, only inferior to the masterpieces of the Dutch School—and in landscape Turner and others have depicted the effects of air and of powerful relief in objects in a way which was never surpassed; yet in the highest walk of art—in giving the movements of the finer or loftier passions of the mind, this country has not produced a single painter who has made even a faint approach to the excellence of the great Italian painters;—and the pictures of Barry, Northcote, West, Fuseli, and Haydon have been instanced in proof of this assertion. But such complaints are most unjustly made: for how should works be expected of a class and quality for which there is neither demand, encouragement, sympathy, nor appreciation? Though it be undoubtedly true that the province of art as well as of literature is to lead and instruct the public mind, yet it is not less certain that both are acted on by, and reflect the feelings, tastes, and habits of, the people; and though for a long time various causes combined to check the progress of art in Britain, since the establishment of the English school its artists have not only energetically kept pace with, but often greatly aided in advancing, the spirit of the age.

When we consider the deplorable state of art when the English school was founded, we cannot admire too much the energy of the movement, and the success with which it was crowned. The eighteenth century was the period in history when art was most debased. All of art that remained to the world was the mannered and tawdry school of Louis XIV., then almost in a state of imbecility; and about the middle of the century when the English school was founded, there was no corresponding movement elsewhere, and bad taste had to be opposed in every direction. The modern French school dates from the end of last century, and at first it was anything but successful. A political bias inclined art to the same walk that literature had taken, namely, the classic, which emanated from the ancient republican states; and as sculpture is the chief expositor of that kind of art, painting was made entirely sculpturesque, and its powers and capabilities were confined within limits and forced in a direction at variance with its proper functions. Within the last thirty years, however, the French school has made great advances, and is now in a flourishing condition.

The modern school of Germany was not founded till the beginning of this century. It arose under most favourable circumstances; for peace had been established in Europe, and the nations required repose after a long and ruinous war, which, however, had dispersed the treasures of art in the various royal galleries, shown the public the value and importance attached to such works, and made their study more generally available. All these movements have combined to improve and elevate taste generally, and in this country in particular, abounding as it does in wealth and energy, they have been eagerly taken advantage of; so that the British school is rapidly attaining the high position that will fit it in every way to respond to the requirements of the greatest and wealthiest nation in the world.

It is now above a hundred years since Hogarth painted his *March to Finchley*. At that period art had fallen low indeed—the glorious schools of Italy and Germany had long passed away, as also had what is styled the revival in Bologna, an attempt that has in general been estimated too favourably, as it did more to injure art than to revive it—the lights of the Spanish, the Flemish, and the Dutch schools were extinguished, and all that remained was the baneful example of the French school of Louis XIV., and even it was in decadence. In Germany, French art as well as French literature alone prevailed, and in England a national school was scarcely hoped for. When Hogarth produced those wonderful works which so powerfully embody English character, he adopted, to a certain extent, in technical treatment, the style of Watteau, the painter, however, of whom France has most reason to boast as a genuine national artist. Thornhill was executing huge sprawling allegories in emulation of De la Fosse and other French painters, portrait painting was chiefly in the hands of foreigners, and landscape painting was almost unknown. Thus we find art everywhere paralyzed at the time when Hogarth and Reynolds arose to revive it—the productions of the former exceeding in humour every previous effort in art, the portraits of the latter ranking with those of Velasquez, Vandyck, and Rembrandt, while the works of their contemporaries, Wilson, Gainsborough, Bacon, &c., are deservedly held in high esteem. There is one striking peculiarity in the English school—it has not like others commenced timidly, risen to a certain point, and then fallen. No greater works have been produced in the English school than those of its founders Hogarth and Reynolds, in their peculiar walks. It has not, however, declined since the days of Reynolds; on the contrary, it has risen much higher. The explanation seems to be this, that the English school was the last that arose in Europe, having been instituted only in the middle of the eighteenth century, and the general revival of art over the greater part of Europe took place before there was any perceptible decadence in Britain. Though that revival therefore affected in the most striking manner the schools of France and Germany, where art was either in utter decay or had long passed away, and was therefore loudly called for and eagerly welcomed, the movement in England is to be viewed less in the light of a revival, than merely as aiding in bringing forth a rich harvest of increased motives and facilities of improvement, for the further sustenance and gradual development and increase of a healthy and vigorous system. Thus, for example, though we have not had a portrait painter superior to Reynolds, yet, admirable though that great painter's works are, increased knowledge has produced an appreciation of art that demands, and doubtless will soon call forth, a higher and purer style, uniting to the force of Reynolds more careful drawing, greater individuality of expression, and higher finish. And though Hogarth has never been excelled for broad humour, still the *Distraining for Rent—Reading the Will—The Penny Wedding*, and *The Chelsea Pensioners* of Wilkie, are higher works than any of Hogarth's, as they combine a greater number of the qualities essential to a complete work of art, and the expression is brought out with greater delicacy and

more artistic skill. The painters also of history and *genre* subjects of the present time go far beyond those who practised in the early period of the school. What works of that day would stand in comparison with those of Etty? In landscape the superiority is even more striking. Turner far surpassed Wilson and Gainsborough,—and Bonnington, Calcott, Collins, P. Nasmyth, Müller, and many others (we avoid names of living artists, and refer only to those lately deceased), may be successfully opposed to them; while our school of water-colour painters, which is of purely English origin, is looked up to and imitated all over Europe.

Besides the revival of art on the continent, a new influence has been brought to bear on British art, by the introduction of an element till lately unknown in this country, namely, government patronage. It was often made a subject of complaint, that while the governments of France and Germany gave liberal encouragement to the arts, the government of our country was noted for neglecting them. But the decoration of the new houses of parliament was at length taken advantage of as affording a fitting opportunity for employing native artists on national works; and about ten years ago competitions were instituted, and prizes offered, both in money and commissions for pictures. The amount of talent called forth in this way far exceeded expectation; and accordingly, several important commissions were awarded for pictures in fresco and in oil, though chiefly in the former style, as a species of painting not hitherto practised in England, and from its being thought best adapted for combining with architectural decoration. Several sculptors, too, —and the English school reckons at present many eminent names in that high walk of art—were employed by government. These commissions, so far as executed, satisfactorily demonstrate the high capabilities of the artists employed; but it is doubtful whether a demand for large works, especially when executed on walls, will become general in this country. There seem many reasons against it: the domestic habits of the people lead them to seek for enjoyment in their private dwellings, and there to collect around them what they prize most; works of large dimensions, therefore, can seldom be accommodated. Besides, largeness of style is in no degree dependent on dimensions of canvas; in a mercantile community too, large sums are seldom laid out without a calculation that it may be necessary at some future time to convert into money the property on which the expenditure was made, and moderately-sized pictures are generally preferred as an investment; and, indeed, extensive mansions adorned with fresco paintings are not now considered, as they were in former times, the means of adding importance to and handing down a family to posterity. Even in Germany, although art was there first fostered by government patronage, artists are turning their attention to private sales as the most lasting source from which art is to be supported. The King of Bavaria built churches principally with the view of encouraging fresco painting, but these have now become so numerous that there is scarcely a pretext for erecting one more; and his palaces, rebuilt or extended for the same purpose, are larger than he can occupy. In France a like feeling is gradually arising, and it has lately been strengthened by the following occurrence. The exiled Duchess of Orleans, in spring of the present year (1853), brought to public sale the gallery of modern French paintings which had been formed by the late duke, and a larger sum was realized than had been expended on the collection. In place of purchasing or commissioning easel pictures, had the duke employed the different artists to execute frescoes in some of his chateaux, they would never have formed a resource for his family in adversity, nor in any way benefited himself or others, as they would probably have been obliterated to make way for compositions illustrative of the deeds of the new dynasty.

Government has also taken up strenuously a plan which, it is strongly hoped, will improve the taste of the people, that, namely, of art tuition in design, particularly with reference to manufactures. With this view a number of schools have been instituted in London, in Edinburgh, and in the principal cities of the kingdom. These have been in operation for several years, most of them having been founded at the same time that government proposed competitions at Westminster Hall with the view of encouraging the fine arts. This latter plan seems, however, to have been discontinued, at least it is being but feebly carried out, while the schools of design are receiving the particular attention of government. On this legislative procedure, public opinion is much divided, many holding that, in place of forming schools where an inferior kind of art is taught, government should encourage only the highest, as that would involve improvement in all the inferior branches; others again—and among these many of the principal manufacturers—think that such schools now attempt too much, the plan having lately been tried, of communicating a practical knowledge of the particular trade or manufacture for which the designs are made. They hold that the education imparted should be limited to drawing and modelling, it being left to the employers and the master-designers in their establishments, to instruct the pupils in the kind of design that can be practically applied to the particular trade they engage in; as the attempt by these schools to turn out practical designers perfected in their profession is hopeless; and the little practical knowledge they can learn at the schools, serving only to puzzle them, must be all unlearned in the manufactory. There can be no doubt, however, that every step taken in disseminating education should be hailed with satisfaction,—that drawing, the medium by which knowledge is directly communicated to the mind through the eye, should be made a part of education as well as letters, and that galleries of art should be acquired by the nation, and be made available to the people in the same way as public libraries are. For it is in vain to educate men to execute fine designs, unless the people who are to purchase those designs are also sufficiently educated to be able to appreciate them.

Much has been written on the subject of artists forming themselves into societies or academies, and it has been alleged that all such institutions are injurious to art. This is surely very unreasonable. Artists are equally entitled to form societies for their mutual benefit and for advancing their profession generally, as members of the legal or medical profession. And if such combinations were injurious to art, it is reasonable to suppose that the artists themselves would be the first to make the discovery, seeing that whatever is detrimental to art must be hurtful to them; and it is surely natural that they should take a deep interest in art-education, and desire that a flourishing school of artists should succeed them, to maintain worthily and to perpetuate that profession to which all their energies have been devoted. The occasional outcry made against government assistance to academies is no good indication of a love of art. The support of that kind that this country has hitherto afforded to academies of art is of the most limited description, and immeasurably disproportionate to the sums expended in the endowment in universities of chairs in the various branches of literature and science, besides the numerous annual grants to learned bodies.

Art in France is perhaps, at present, in a more healthy state than it has been in any former period; for though entitled to claim, on the ground of birth, many eminent artists who flourished in past ages, the only really national French school was that of Louis Quatorze, which sprung up in an age when the standard of taste was extremely low. This school, when almost exhausted, was swept away at the Revolution; and the hard and exaggerated imitations of classic art then substituted, have not only been now much modified, but many of the artists of the French school have en-

tered on several other walks of art, in which they have displayed great talent. We shall enumerate some of the chief French artists of the present day, and note generally their distinguishing styles.

Horace Vernet is celebrated for his pictures of the various battles in which the French have been engaged. These are mostly executed on a large scale, and are remarkable for truth and power. He has also painted a variety of subjects from sacred history, treated in a very original manner, by assuming that the Arabian costume has undergone little change since the time of the patriarchs, whom accordingly he has dressed like Arabs; and by introducing in his backgrounds truthful delineations of Eastern scenery. The novelty of this style, and the forcible manner in which Vernet has carried it out, has made it popular in France. Many able artists have adopted it, and it is as much the characteristic of the French school now, as the classic was at the commencement of this century.

The classic school founded by David, but much modified and improved, is at present represented by Ingres, and his works are highly estimated in France.

Delaroche holds, perhaps, as high a position as any French artist; his subjects are historical, and range from the medieval period to modern times; his works are characterized by good drawing, carefully studied expression, and correct costume and accessories. He is one of the chief artists of what is styled the romantic, in contradistinction to the classic school, of which, as before stated, Ingres is now the leader.

Airy Scheffer also belongs to the romantic school, his subjects are almost entirely medieval, and his style partakes of German feeling to a greater extent than that of any other French artist.

Delacroix belongs to a department of the romantic school in which the attempt to introduce into it something of the rich colouring of the Venetian school has been made with much success. This fascinating style of art was introduced into France by the English artist Bonnington.

The *genre* subjects of Meissonier, which are of small dimensions and exquisitely finished, are highly valued.

Did our space permit, we could, in addition, enumerate many men of high ability, whose works, while they never fail to prove that our neighbours possess great readiness and facility in drawing, often display an amount of talent and originality highly creditable to French art.

The modern school of Germany deservedly holds a high rank, and in purity and elevation of style is superior to that of France. It is not older than the present century; and though in former ages there was a celebrated German school, of which there are many admirable examples extant, and it might be supposed that there would be a national bias in favour of this ancient school, still it can scarcely be called a revival of German art, as the founders of the modern school seem to have modelled their style not so much on old German as on early Italian art. They probably wished to adopt the purest model, and imagining that Italian art best afforded this, they resolved to be guided chiefly by its light. Many of the most distinguished German artists have sprung from the school of Dusseldorf. In this city there was at one time a celebrated gallery of pictures consisting chiefly of the *chef d'œuvres* of Rubens; but it so happened that one consequence of the various state partitions in Napoleon's time, was the transference of the Dusseldorf gallery to Munich the capital of Bavaria. But this spoliation, which at the time was looked upon by the Dusseldorfers as a heavy blow to their city, was the most fortunate thing for it that could have happened. German patriotism and talent more than made up for the loss, and the modern school that was founded in place of the Rubens gallery has produced a band of artists whose talents have made Dusseldorf celebrated all over Europe. German art owes much to state patronage; all the most eminent artists have been employed on important works by the kings of Bavaria, Prussia, and Saxony, and other German princes. Though the German artists adopted Italian art as the basis of their style, yet different artists chose the art of different epochs as their examples. Overbeck, whose pencil is chiefly devoted to religious subjects, studied the works of Fra Angelico, a painter who flourished about a century before Raphael, and whose style is distinguished by deep feeling and simplicity; while Cornelius, whose range is more extensive, embracing both classical and religious subjects, has been influenced by the works of M. Angelo, and the art of the cinquecento period. Kaulbach is more German in feeling: his *Battle of the Huns* and the *Taking of Jerusalem* are grand compositions. The frescoes executed by Bendeman at Dresden; by Cornelius, Schnor, and Hess at Munich; by Viet at Frankfort; by Stienle at Cologne; and at Dusseldorf, Elberfeld, Rheinstein, &c., by Sättegast, Müche, Deger, and others; and the easel pictures of Schadow, Müller, Rethel, Hildebrandt, Sohn, Lessing, Köhler, Riedel, one of the best colourists of the German school, Achenbach, Calame, and Schermer, landscape painters, and many others, have raised modern German art to a very high position, higher, indeed, in the opinion of many, than that of any other country at present.

Of course this pre-eminence is not generally admitted either by the artists of France or England. Many, however, of the most celebrated French artists (Airy Scheffer, for example) have evidently profited by studying German art; and there can be no doubt that good examples of art are more generally diffused among the people in Germany than in England or France. Even in their story and song books, although for the sake of cheapness the illustrations are roughly executed on wood, and printed on coarse paper, the drawing and composition evince the highest artistic feeling. In this country, again, we have cheap publications for the people, excelling those of every other nation in the literary department, and, in so far as paper, printing, and the mechanical skill of the wood-cutting are involved, far superior to the German publications. But the designs have not their purity of drawing and artistic feeling; and the dashing cleverness of execution in the English woodcuts, is rather to be blamed than praised, as indicative of a rashness and presumption requiring to be checked and kept in proper bounds by judgment formed on cultivated taste. The position of engraving, too, affords a fair criterion of the state of taste, and that is admitted to be higher in Germany at present than anywhere else. Line engraving, which alone can express the true feeling of good art, has some able professors in France, but in this country the aid of machinery, by which manual labour is saved, and a straining at effect, and what by engravers is called colour, has lowered the art, and line has been almost superseded by the inferior styles of mezzotinto and stipple engraving.

But let us refrain from farther comparisons; those we have indicated being made solely with the view of still farther exciting honourable emulation; and this, there can be no doubt, has been lately aroused by the great facilities of intercourse among nations, and the national exhibitions. The purity of design of the German school, and the variety and dexterity displayed in that of France, are qualities now generally admitted by the artists of this country, and anxiously noted with feelings of respect, and not slightingly as in former times; while the Germans and French, by their efforts, prove daily that they admire, and are anxious to infuse into their works, the brilliant colouring and truth to nature which have long been characteristics of the British school. (W. H—Z—T.) (W. B. J.)

Arts, *Degrees in*. See Universities.

ARUNDEL, a borough and market town in the county of Sussex, 57 miles from London. It is situated on the declivity of a hill, on the north bank of the river Arun, which is navigable for vessels of 200 tons, and consists of two principal streets, containing several houses of a superior class. Adjoining to it is the magnificent castle of the dukes of Norfolk. The municipal government is vested in a mayor, four aldermen, and twelve councillors. It returns one member to parliament. Its chief trade is in corn and timber. Pop. in 1851, 2748.

Arundel, *Thomas*, archbishop of Canterbury, born in 1353, was the second son of Robert, Earl of Arundel and Warren. At 22 years of age he was raised to the bishopric of Ely, to the church and palace of which he was a great benefactor. In 1386 he was appointed lord chancellor of England; two years after he was translated to the see of York, and in 1396 was advanced to the primacy of Canterbury, when he resigned the chancellorship. This was the first instance of the translation of an archbishop of York to the see of Canterbury. Scarcely was he fixed in this see, when he had a contest with the university of Oxford about the right of visitation. The affair was referred to the king, Richard II., who determined it in favour of the archbishop. At his visitation in London, he revived an old constitution, by which the inhabitants of the respective parishes were obliged to pay to their rector one halfpenny in the pound out of the rent of their houses. In 1398, in the parliament held at London, the Commons, with the king's leave, impeached the archbishop, together with his brother Richard Earl of Arundel, and the Duke of Gloucester, of high treason. He was sentenced to be banished, and within forty days to depart the kingdom on pain of death. He retired, first to France, and then to the Court of Rome, where Pope Boniface IX. gave him a kind reception, and nominated him to the Scottish archbishopric of St Andrews. He was engaged in the plot to depose Richard, and place the Duke of Lancaster on the throne; and returning to England along with him, he was restored to his see on Henry's accession. Two years after, the Commons moved that the revenues of the church might be applied to the public service; but Arundel opposed the measure with such vigour that it was thrown aside. In the year 1408 his zeal for the suppression of heresy was directed against the followers of Wickliffe. The most eminent victim of his persecution was Sir John Oldcastle, Lord Cobham. He also procured a synodical constitution, which prohibited the translation of the Scriptures into the vulgar tongue. This prelate died at Canterbury on the 20th February 1413, of an inflammation in his throat, with which he was seized, as affirmed by the Lollards, while pronouncing sentence upon Lord Cobham.

ARUNDELIAN or Oxford Marbles. These interesting relics of antiquity, which include the famous Parian Chronicle, derive their name from Thomas Earl of Arundel, or from his grandson the Hon. Henry Howard, (afterwards Duke of Norfolk) who presented the collection to the University of Oxford in the year 1667. They were purchased for the first proprietor in 1624 by Mr William Petty, an able antiquary employed by the Earl of Arundel to collect marbles, books, statues, and other curiosities in Italy, Greece, and Asia Minor. On their arrival in London in the year 1627 they were placed in the gardens of Arundel House, the site of which is now occupied by Arundel, Norfolk, Surrey, and Howard Streets in the Strand.

The Parian Chronicle, or Marmor Chronicon, was, when found, a large oblong slab of Parian marble, on which was engraved in capital letters a chronological compendium of the principal events of Greece during a series of 1318 years, beginning with the reign of Cecrops, B.C. 1582, and ending with the archonship of Diognetus, B.C. 264. This marble originally measured three feet seven inches and two feet eleven inches on the two sides respectively, its breadth being two feet seven inches; but the chronicle of the last 90 years is lost, so that the part now remaining ends at the archonship of Diotimus, 354 years before the birth of Christ; and in this fragment the inscription is at present so much corroded and effaced that the sense must in some measure be supplied by conjecture.

Immediately on their arrival they excited the greatest curiosity, and were examined by some of the most eminent literary men of the period; among others by Sir Robert Cotton, Selden, Patrick Young, and Richard James. Selden, along with Patrick Young, or, as he styled himself in Latin, *Patricius Junius*, and Richard James, immediately commenced their operations by cleaning and examining the marble containing the Smyrnean and Magnesian league, and afterwards proceeded to the Marmor Chronicon. The following year Selden published a small volume in quarto, including about 39 inscriptions copied from the marbles.

In the turbulent reign of Charles I., and the subsequent usurpation, Arundel House was often deserted by the illustrious owners; and, in their absence, some of the marbles were defaced and broken, and others either stolen or used for the ordinary purposes of architecture. The chronological marble, in particular, was unfortunately broken and defaced. The upper part, containing 31 epochas, is said to have been worked up in repairing a chimney-piece or hearth in Arundel House.

Selden's work becoming very scarce, a new edition of the inscriptions, by Prideaux, was printed at Oxford in 1676. In 1732 Maittaire obliged the public with a more comprehensive view of the marbles than either of his predecessors. Lastly, Dr Chandler published, in 1763, a new and improved copy of the marbles; in which he corrected the mistakes of the former editors, and in some of the inscriptions, particularly that of the Parian chronicle, supplied the *lacunæ* by many ingenious conjectures.

The Arundelian marbles, though generally regarded as genuine relics of antiquity, were, however, discovered in some instances to differ somewhat from the most authentic historical accounts. Sir Isaac Newton and several other eminent philosophers paid little or no regard to them; and their absolute authenticity has been severely questioned in an express dissertation upon the subject by the Rev. J. Robertson, published in 1788, entitled *The Parian Chronicle*. In this dissertation much ingenuity as well as learning is displayed, and the arguments are doubtless possessed of considerable force and plausibility; but Mr Robertson's dissertation has been ably answered, and the authenticity of the Parian chronicle vindicated, by several writers; particularly the late Professor Porson, in an examination of Mr Robertson's Dissertation, in the *Monthly Review* for January 1789. See also Hewlett's *Vindication*, and the *Archæologia*, vol. ix.

ARUSPICES, or Haruspices, in *Roman Antiquity*, an order of priests who pretended to foretell future events by inspecting the entrails of victims killed in sacrifice; and who were consulted on occasion of portents and prodigies. The aruspices were chosen from the best families; yet although their employment was of the same nature as that of the augurs, and they were much honoured, they never acquired the same political importance, being regarded rather as mere interpreters of the will of the gods, than as possessing any religious authority. Their college, as well as those of the other religious orders, had its particular registers and records.

ARVA, a county of northern Hungary, containing above 101,000 inhabitants. Its surface = 797 square miles, with extensive forests, 5 market-towns, and 92 villages.

ARVALES Fratres, in *Roman Antiquity*, a college of twelve priests, instituted by Romulus, and chosen out of

the most noble families, he himself being one of that body. They assisted in the sacrifices of the Ambarvalia, offered to Ceres and Bacchus in May for the prosperity of the fruits of the earth, when they wore on their heads crowns made of ears of corn. The origin of this institution was said to have been as follows. Acca Laurentia, Romulus's nurse, was accustomed once a year to make a solemn sacrifice for a blessing on the fields, her twelve sons always assisting her in the solemnity. On the death of one of them, Romulus offered himself to supply his place, and gave this small society the name of *Arvales Fratres*. This order was in great repute at Rome: they held the dignity for life, and never lost it on account of imprisonment, banishment, or any other accident. See AMBARVALIA.

ARVE, a well-known river which rises in the Col de Balme, one of the Savoyan Alps, and passing through the valley of Chamouni, falls into the Rhone near Geneva, after a course of about 50 miles.

ARVIL SUPPER, a feast or entertainment made at funerals in the north part of England. Arvil bread is the bread delivered to the poor at funeral solemnities.

ARVIRAGUS, a British king in the time of the Emperor Domitian. He gained a complete victory over Claudius; but being soon after besieged in the city of Winchester, he made a treaty with the Romans, and married the emperor's daughter Genuissa. This monarch lived to a good old age: he confirmed the ancient laws, enacted new ones, and liberally rewarded persons of merit.

ARX, in all ancient cities, was a fortified eminence or rock, either within or close by the city itself. The arx at Rome was a part of the Capitoline Hill, the other part containing the Capitoline temple. In Greek towns the arx was called ἄκρα or ἀκρόπολις, and in several of them it bore a distinct name; whence at Thebes it was called the Cadmea, at Argos Larissa, at Corinth Acrocorinthus, and at Athens, sometimes Cecropia, or simply ἡ πόλις. The modern name citadel does not correspond with the term arx in every respect, the latter being always situated on an eminence. (L.S.)

ARX also denotes a consecrated place on the Palatine Mount, where the augurs publicly performed their office. Some suppose the arx to have been the augural temple, but Varro expressly distinguishes between the two.

ARX was particularly used for a public place in Rome, set apart for the operations of the augurs; and is the same as what is otherwise called *auguraculum* and *auguratorium*, and in the camp *augurale*. Out of this arx it was that the *feciales*, or heralds, gathered the herbs used in the ceremony of making leagues and treaties.

ARZEW (the ancient *Arsenaria*), a seaport town of Algiers, province of Oran, on a bay of the same name. Long. 0. 16. 58. W. Lat. 35. 51. 39. N. The modern town is ill-built and inconsiderable, but has many fine Roman remains, and vast cisterns of the ancient city. About 5 miles distant there are numerous salt-pits.

ARZILLA, a small fortified town of Marocco, province of Fez, with about 1000 inhabitants. The battery mounts about 20 guns.

AS, in *Antiquity*, a weight, consisting of 12 ounces, being the same with *libra*, or the Roman pound. The word is derived from the Greek ἄις, which, in the Doric dialect, is used for εἷς, *one*, q. d. an entire thing: or, according to others, from *æs*, because made of brass.

It was also the name of a Roman coin, which was of different weight and material in different ages of the commonwealth. Under Numa Pompilius, according to Eusebius, the Roman money was either of wood, leather, or shells. In the time of Tullus Hostilius it was of brass, and called *as libra*, *libella*, or *pondo*, because actually weighing a pound or 12 ounces. The first Punic war, 420 years later, having exhausted the treasury, the *as* was reduced to two ounces. In the second Punic war, it was again reduced to half its weight, viz., to one ounce. And lastly, by the Papirian law it was still further reduced to the diminutive weight of half an ounce; and it is generally thought that it continued the same during the commonwealth, and even to the reign of Vespasian. The *as*, therefore, was of four different weights in the commonwealth. Its original stamp was that of a sheep, ox, or sow; but from the time of the emperors it had on one side a Janus with two faces, and on the reverse the rostrum or prow of a ship.

As also denoted any integer or whole; whence the English word *ace*. Thus *as* signified the whole inheritance; whence *hæres ex asse*, the heir to the whole estate.

ASAHEL (*i. e. God's creature*) son of David's sister Zeruiah, and brother of Joab and Abishai. He was noted for his swiftness of foot; and after the battle at Gibeon he pursued and overtook Abner, who, with great reluctance, and to preserve his own life, slew him with a backthrust of his spear, B.C. 1055.

ASAPH (*i. e., assembler;* Sept. Ἀσάφ), a Levite, son of Barachias, eminent as a musician, and appointed by David to preside over the sacred choral services which he organized. The "sons of Asaph" are afterwards mentioned as choristers of the temple, and this office appears to have been made hereditary in his family (1 Chron. xxv. 1, 2). The titles of twelve of the Psalms (lxxiii. to lxxxiii.) bear his name.

ASAPH, *St*, a small episcopal city of North Wales, county of Flint, 20 miles west of Chester, and 208 north-west of London. It is agreeably situated on an eminence near the northern extremity of the fertile vale of Clwyd, between the rivers Elwy and Clwyd, not far from their confluence. The city is small, consisting principally of a single street. It has a cathedral, a church, four chapels, a free grammar-school, Bishop Barrow's almshouse for eight widows, a bank, and a bridge of five arches over the Elwy. Since the passing of the Reform Act, it is a contributory borough to Flint. Pop. of borough in 1851, 2041.

The see is very ancient, having been established in the middle of the sixth century by Kentigern, otherwise called St Mungo, bishop of Glasgow. Driven from the north by persecution, he sought refuge here, and was protected by Cadwallon, who aided him in building a church and founding a college or monastery in this place. Being recalled to his original charge, he nominated as his successor a pious scholar named Asa or Asaph, from whom both the church and town received their designation. Whether Kentigern assumed the title of bishop while here is not known, but there is evidence that Asaph certainly did, and that on his death in 596, he was interred in his own cathedral. The first edifice, which was of wood, was consumed by fire in 1282. A more substantial building was soon afterwards erected by Bishop Anian; and this was nearly destroyed during the wars of Owen Glyndwr. It was partially rebuilt by Bishop Redman about 1480, but the choir remained unfinished till about 1770, when it was completed by the dean and chapter. In the parliamentary wars the edifice was converted into a barrack, and sustained great injury.

The present cathedral is a neat plain cruciform structure, with a square tower 93 feet high rising from the intersection of the nave and transepts. Its length from east to west is 179 feet, its breadth at the transept 108 feet, and at the nave and side aisles 68 feet. The east end is lighted by a large window, an imitation of one at Tintern Abbey, filled with modern stained glass; and several other stained windows have been added at different times. Among its monuments are an altar-tomb supporting a recumbent figure in episcopal robes, in memory of Bishop Dafydd ap Owen, who died in 1502; a full-length figure, in white marble, of Dean Shipley; an altar-tomb recording the decease of

Bishop Luxmore in 1830; and a mural tablet in memory of the poetess Felicia Hemans, who, during a great portion of her life, resided in the vicinity.

The episcopal palace is a large modern structure a little to the west of the cathedral, overlooking the Elwy. The parochial church, dedicated to St Asaph and St Kentigern, is situated at the foot of the hill of which the cathedral occupies the summit. The rivers in the neighbourhood abound with fish, and are much resorted to by anglers. There are also some remarkable caverns and other places of interest in the vicinity.

Among the prelates of this diocese may be especially named Bishop William Morgan, an eminent linguist, and the principal translator of the Welsh Bible, printed in 1588; Dr Isaac Barrow, uncle and preceptor of the great mathematician of the same name; Dr William Beveridge, an eminent orientalist and critic, as well as a devout, zealous, and useful theologian; and Dr Samuel Horsley, celebrated as a scholar, mathematician, and theologian.

ASAR-ADDON, or ESAR-HADDON. See ASSYRIA.

ASAROTUM (from α, privative, and σαίρω, I sweep), an ancient kind of mosaic pavement composed of coloured pebbles. The most celebrated was that at Pergamus, executed by Sosus, which exhibited the appearance of an unswept floor after a banquet, whence the chamber was called ἀσαρωτὸς οἶκος. The central part represented several doves sitting on the edge of a *cantharus*, and the image of one in the act of drinking was reflected in the water. An imperfect copy of this central group was found at Tivoli in 1737, and another, in better preservation, was discovered at Naples in 1833.—See Plin. xxxvi. 25.

ASBESTOS. See AMIANTHUS, and MINERALOGY.

ASCALON, or ASKELON (now called Askulan), a chief city of one of the five states of the Philistines, situated on the coast of the Mediterranean between Gaza and Ashdod, 12 geographical miles north of the former, 10 south by west of the latter, and 37 W.S.W. from Jerusalem. Ascalon was assigned to the tribe of Judah, but was never for any length of time in the possession of the Israelites. It afterwards fell successively into the hands of the Greeks, the Romans, and the Arabs. At the period of the first crusade it, as well as Jerusalem, was in the possession of the Khalifs of Egypt. The crusaders having advanced to Jerusalem, a very formidable Egyptian army, composed of Arabs, Turks, and Africans, hastened to defend it. When this army arrived after the capture of the holy city, it halted in a plain near Ascalon, while the Egyptian fleet took up its position along the shore. On receiving intelligence of this, Godfrey of Bouillon, and Tancred, issued out of Jerusalem with all their available forces to attack the enemy. The Christian army was very inferior in numbers to that of the Egyptians, but their former success and the conviction that God was on their side rendered them invincible. The battle was fought on the 15th of August 1099, and the slaughter of the Egyptians is said to have amounted to a fourth part of their whole forces, which consisted of 400,000 men. In the account of this battle given by Tasso in his *Jerusalem Delivered*, the poet has freely used his license. This signal victory was not followed up as would have been expected by an attack upon Ascalon, so that that city remained in the possession of the Egyptians till 1157, when it was taken by Baldwin III. king of Jerusalem, after a siege of five months. When Saladin had defeated and almost annihilated the Christian army in the plains of Tiberias, in 1187, Ascalon offered but a feeble resistance to his victorious army, surrendering after a siege of four days. Saladin repaired and strengthened its fortifications; but alarmed at the capture of Saint Jean d'Acre by the Crusaders under Richard Cœur de Lion in 1191, he caused Ascalon to be dismantled. From this time Ascalon lost much of its importance, and at length in 1270 its fortifications were totally destroyed by the Sultan Bibars, who filled up its port with stones to prevent its again falling into the hands of the Christians. This sealed the ruin of Ascalon, of which little now remains but the walls and fragments of granite pillars. The situation is described as strong; the thick walls, flanked with towers, were built on the top of a ridge of rock that encircles the town, and terminates at each end in the sea, and the ground within sinks in the manner of an amphitheatre.

ASCANIUS, the son of Æneas and Creusa, succeeded his father in the kingdom of the Latins, and defeated Mezentius, king of the Tuscans, who had refused to conclude a peace with him. He migrated to Alba Longa, and here he was succeeded by his son Silvius. Some writers relate that Ascanius was also called Ilus or Iulus, whence the origin of the *gens Julia* at Rome, who regarded Ascanius or Iulus as their ancestor. Horace elegantly alludes to this in addressing Augustus:—

Micat inter omnes
Julium sidus, velut inter ignes
Luna minores. Carm. 1. i. 12.

ASCENDANT, in *Astrology*, denotes the horoscope, or the degree of the ecliptic which rises upon the horizon at the time of the birth of any one. This is supposed to have an influence on the person's life and fortune, by giving him a bent and propensity to one thing more than another. In the celestial theme this is also called the *first house*, the *angle of the East*, or *Oriental angle*, and the *significator of life*. Such a planet ruled in his *ascendant*, Jupiter was in his *ascendant*, &c. Hence the word is also used in a moral sense for a certain superiority which one man has over another from some unknown cause.

ASCENSION, a solitary island in the Atlantic Ocean, Lat. 7. 55. 56. S., and Long. 14. 23. 50. W.; about 7½ miles in length, and 6 in breadth, and within the immediate influence of the south-east trade-wind. The whole character of the island is volcanic, and its surface is broken into mountains, hills, and ravines. Towards the south-east, the Green Mountain, the highest in the island, rises 2870 feet above the level of the sea, while the plains or table-lands surrounding it vary in height from 1200 to 2000 feet. On the north side they sweep gradually down towards the shore; but, on the south, they terminate in bold and lofty precipices. Steep and rugged ravines intersect the plains, opening into small bays or coves on the shore, fenced with masses of compact and cellular lava; and all over the island are found the usual products of volcanic action. The chief productions of the island now are green vegetables. Ascension was formerly noted for the abundance of turtle and turtle eggs found on its shores. The coasts abound with a variety of fish of excellent quality. The native wild animals are guinea-fowl, goats, cats, rats, and land-crabs; but the goats have been almost exterminated to make way for sheep and cattle. The air is clear and elastic, and the climate remarkably salubrious. The island was discovered by the Portuguese on Ascension day 1501; but remained uninhabited till after the arrival of Napoleon at St Helena, when it was taken possession of by the British Government, and it now forms a permanent station. The garrison, with their retainers, reside in George Town, on the north-west coast, which is abundantly supplied with fresh water from a magnificent cistern capable of containing 1700 tons of water, supplied by means of iron pipes from springs in the Green Mountain, six miles distant. Population about 400, including the garrison. Ascension is found useful as a station and rendezvous for the vessels employed on the coasts of Africa and Brazil. A crevice in one of the rocks was long known as *the sailor's post-office*, because letters were deposited there to be taken up by the next ship passing in a contrary direction.

Ascension Day, a festival of the Christian church held ten days before Whitsuntide, in memory of our Saviour's ascension into heaven.

Ascension, *right* and *oblique*. See Astronomy.

ASCETERIUM (from ἀσκήτης, *one who exercises*), in ecclesiastical writers, is frequently used for a monastery, or place set apart for the exercise of virtue and religion. Originally it signified a place where the athletæ or gladiators performed their exercises. Plato, *Gorg.* 42.

ASCETIC (from ἀσκέω, *I exercise*), an appellation given to such persons as, in the primitive times, devoted themselves to the exercises of piety and virtue in a retired life, and particularly to prayer, abstinence, and mortification. Afterwards this title was bestowed upon the monks, especially upon such of them as lived in solitude.

ASCHAFFENBURG, a city of Bavaria, in the circle of Lower Franconia and Aschaffenburg. It is pleasantly situated on the right bank of the Maine, here crossed by a stone bridge, 23 miles E.S.E. of Frankfort. It is surrounded by walls on every side, but that towards the river is indifferently built, and the streets are mostly narrow and crooked. On a commanding eminence stands the palace of Johannisburg, a large square edifice with a tower at each angle, and magnificent gardens attached. It was founded by the elector of Mentz in 1606, and is at present the ordinary summer residence of the king of Bavaria. Aschaffenburg has seven churches, one of which is an old Gothic building with the tombs of its princes; a public library of 22,000 volumes; a picture-gallery, gymnasium, lyceum, and an ecclesiastical seminary. Its manufactures are woollens, soap, leather, and coloured paper; and it has a considerable trade in timber, wine, and tobacco. Lat. 49. 58. 28. N. Long. 9. 8. 50. E. Pop. 10,000.

The principality of Aschaffenburg, which derived its name from this city, comprehended an area of 336 geographical square miles. It originally formed part of the electorate of Mentz, and in 1803 was made over to the archchancellor, Archbishop Charles of Dalberg. In 1806 it was annexed to the grand duchy of Frankfort; and in 1814 was transferred to Bavaria in virtue of a treaty concluded on 19th June between that power and Austria. Conjointly with Lower Franconia it now forms a circle of the kingdom of Bavaria.

ASCHAM, Roger, a very distinguished scholar and writer, was born at Kirby Wiske, a village in Yorkshire, near Northallerton, about the year 1515. John Ascham, his father, was house-steward in the family of Scroop, and by his wife Margaret was connected with several respectable families. A short time before his death, Sir Anthony Wingfield having conceived a predilection for his third son Roger, took him into his family, and extended his bounty so far as to give him the advantage of a private education along with his own sons. Under a domestic tutor he made a rapid progress in classical learning, and early discovered a great partiality for reading. The superiority of genius and docility of temper which he constantly displayed induced his patron to send him to St John's College, Cambridge, in the year 1530.

The revival of Grecian and Roman literature at the period Ascham entered upon his studies was peculiarly favourable to the natural bent of his inclination. A desire of excelling uniformly influenced his conduct, and, adopting the maxim *Qui docet discit*, he began to teach boys the rudiments of the Greek language as soon as he was acquainted with the elementary parts himself. His plan was approved by Pember, and under the direction of this valued friend he soon became acquainted with the best Greek and Latin authors. But he took particular delight in reading Cicero and Cæsar, and upon them formed the elegance of his Latin style, which proved so honourable and so advantageous in the after part of his life.

Ascham took his degree of bachelor of arts in his 18th year, and was chosen fellow of the college about a month afterwards. The favourable disposition, however, which he manifested towards the reformed religion was no small obstacle in the way of his preferment. He was admitted master of arts in the year 1537, and about this period he began to act in the capacity of a tutor.

His reputation for Greek learning soon brought him many pupils; several of whom afterwards rose to considerable eminence. Of these one of the most distinguished was William Grindall, who obtained the station of master of languages to the Lady Elizabeth, upon the recommendation of Sir John Cheke. The reason why Ascham himself was not appointed to that honourable office is not known; but his partiality for the university seems, from a hint in one of his letters, to have been the cause. At that period there was no particular chair appropriated to the Greek language, but Ascham was appointed by the university to read lectures upon that language in the schools. A dispute arose in the university at that time about the pronunciation of the Greek language, in which Ascham first opposed the method observed by Sir John Cheke and Sir Thomas Smith; but, upon more mature deliberation, he adopted that method, which has ever since been practised in the English schools. Both on account of the beauty of his handwriting, and the purity and elegance of his Latin, he was employed to write the public letters of the university.

By the advice of his friend Pember, he turned his attention to the study of instrumental music, and thereby enlivened his leisure hours, and prepared his mind for renewed exertion. In his study he also amused himself with embellishing the pages of his manuscripts with beautiful draughts, and in the field he joined in the diversion of the bow and arrow. The learned Ascham did not deem his labour improperly bestowed in writing a book entitled *Toxophilus*, in an age when the proper use of the bow was of more importance than for mere amusement. This work was written in a more natural, easy, and truly English diction than had hitherto been in use; and it also abounds with many beautiful allusions and curious fragments of English history. Ascham candidly acknowledges, that being anxious to make the tour of Italy, which was then the great republic of letters, and particularly of Grecian literature, he wished, by dedicating his book to the king, to obtain a pension to enable him to make that tour. It reflects some credit on Henry VIII. that in the year 1544 he settled upon him an annual pension of L.10, which Dr Johnson estimates at the value of L.100. Upon the death of Henry this pension was renewed by Edward VI., to whom he was afterwards appointed Latin secretary. In the same year, also, Ascham obtained the appointment of orator to the university; an office which he retained with great reputation during the period he was connected with the university.

For some years he received an annual gratuity from Lee, archbishop of York, but to what amount is not recorded; and, in 1548, upon the death of his pupil Grindall, preceptor to the Lady Elizabeth, his pupils and writings had acquired him such celebrity, that he was appointed to direct the studies of that princess. He successfully acquitted himself in that honourable charge; but two years after, from some unknown cause of dissatisfaction, he returned to the university, having taken an abrupt leave of the princess. This part of his conduct did not greatly affect his favour with royalty; for in the same year he was recalled to court, and appointed secretary to Sir Richard Morisine, ambassador to the Emperor Charles V. On his way to London he paid a visit to Lady Jane Grey, whom he found in her chamber reading Plato's *Phædo*, in Greek, "and that," says he, "with as much delight as some gentlemen would read a merry tale in Boccace;" while the duke and duchess, and the rest of the household, were hunting in the park.

In the character of secretary to Sir Richard, besides aiding him in the management of his public affairs, he also conducted his private studies. During the mornings of four days in the week he read with him a portion of Herodotus or Demosthenes, and in the evenings some pages of Sophocles or Euripides: on the other mornings he wrote the letters of public business, and on the evenings he either wrote his own private letters or continued his diary and remarks. While Ascham was on his travels, he made a short excursion to Italy; but was much disgusted with the manners of the people, especially of the Venetians. After his return from that tour, he favoured the world with a curious tract, entitled *A Report and Discourse of the Affairs and State of Germany*, &c.

Upon the death of Edward VI. Morisine was recalled, and Ascham returned to the university. But the fortune of Ascham soon took a favourable turn, through the interest of Bishop Gardiner, who, although he knew him to be a Protestant, obtained for him the office of Latin secretary to the queen, with a salary of L.20 a year, and permission to retain his university emoluments. The prudence of Ascham enabled him to act a respectable part, both under the intolerant reign of Mary, and also in the most perilous situations during the reign of Elizabeth; and the readiness and elegance of his Latin style rendered him a useful member at court. He is reported to have written, during the course of three days, 47 letters to persons in the highest ranks of life.

When the crown passed to Elizabeth, it made little alteration in the condition of Ascham, who still retained his station. He spent several hours every day in reading the learned languages with the queen. Her proficiency was equal to his pains; and it might have been expected that his services would have received some reward more ample than L.20 per annum, together with the prebend of Westwang. The allegation that the queen kept him poor because he was extravagant and addicted to cock-fighting, is hardly satisfactory.

In consequence of a conversation which took place in the apartment of secretary Cecil, upon the subject of education, Sir Richard Sackville, who was present, requested Ascham to write a book on the general subject of education. This work is entitled *The Schoolmaster*, and contains many excellent instructions to the teachers of youth. It was published by his widow after his death. By too close application to composing a poem, which he intended to present to the queen on the New-year's day of 1569, he was seized with an illness which proved fatal. He died on the 23d of December 1568. His death was universally lamented, and the queen expressed her regret by saying, that "she would rather have lost L.10,000 than her tutor Ascham." His epistles, which are valuable both on account of their style and historical information, were published after his death, and dedicated to the queen: the best edition is that of Elstob, published at Oxford in 1703. His English works were published in 4to, with a life by Dr Johnson, in 1767. This edition has been reprinted in 8vo.

ASCHERSLEBEN, a circle in the government of Magdeburg and province of Saxony, in Prussia, formed out of a part of the principality of Halberstadt and the abbey of Quedlinburg. It contains 198 square miles, or 126,720 acres. Pop. in 1849, 49,816. The Bode and the Eine are the chief rivers; and on their banks the land is highly fertile, producing corn, flax, and rape-seed. Quedlinburg is the chief city of the circle.

ASCHERSLEBEN, a city in the circle of the same name, containing 1214 houses and 12,139 inhabitants. It has an extensive trade in friezes, flannels, and other woollen goods, and in linen, leather, tobacco, and rape-oil.

ASCII (α, priv. and σκία), an appellation given to those inhabitants of the earth who at certain seasons of the year have no shadow: such are all the inhabitants of the torrid zone when the sun is vertical to them.

ASCITÆ (from ἀσκός, *a bag* or *bottle*), a sect of the Montanists, who appeared in the second century. They were so called because they introduced a kind of Bacchanals into their assemblies, who danced round a skin or bag blown up, saying they were those new bottles filled with new wine whereof our Saviour makes mention, Matth. ix. 17.

ASCITES (from ἀσκός), an old name for peritoneal dropsy.

ASCLEPEIA, a festival of Æsculapius (Ἀσκλήπιος), the god of physic, observed particularly at Epidaurus every five years, where it was attended with a contest between the poets and musicians, whence it was likewise called Ἱερός Ἀγῶν, *the sacred contention*. It was celebrated on the eighth day of the month Elaphebolion (March).

ASCLEPIAD, in *Ancient Poetry*, a verse composed of four feet, the first a spondee, the second a choriambus, and the last two dactyls; or of four feet and a cæsura, the first a spondee, the second a dactyl and cæsura, then two dactyls; as, *Mæcenas atavis edite regibus.*

ASCLEPIADÆ, the descendants of Asclepius, or Æsculapius, by his sons Machaon and Podalirius, who were physicians in the Greek army, and ruled over Tricca, Ithome, and Œchalia. Combining the functions of priest, prophet, and physician, they spread themselves, along with the worship of the god, over Greece and Asia Minor. They may be regarded as the founders of scientific medicine. They resided in the temples of the god, and there wrought cures of the sick by various remedies, by charms, incantations, and also by means which are supposed to have reference to magnetism. The *Sermones Sacri* of the orator Aristides contain some curious accounts of these mysterious cures. This order undoubtedly had its origin in Egypt, whence the *coluber Æsculapii*, or sacred serpent, was brought by the Phœnicians to Epidaurus the chief seat of the god. Strangers, as Galen reports, were eventually initiated into the mysteries of this order. The priests were bound by a solemn oath not to divulge the secrets of their knowledge. Hippocrates, who was himself of the fraternity, has preserved the form of adjuration used on such occasions. The worship of Æsculapius was introduced at Rome in B.C. 293, for the purpose of averting a pestilence.

The name Asclepiades was borne by a great number of physicians, of whom the most famous was a native of Prusa in Bithynia, who was the founder of the methodical school, and practised at Rome about B.C. 50.

ASCLEPIODORUS, a famous Athenian painter cotemporary with Apelles. See *Index*.

ASCOLI (the *Asculum Picenum* of the Romans), an ancient episcopal city of Italy, States of the Church, and capital of a delegation of the same name. It is situated on the right bank of the river Tronto, at the junction of that river with the Castellano, 53 miles south of Ancona. It is a handsome and well-built town, with a cathedral and numerous churches, many of which are ornamented with valuable paintings by native artists. It has also a Jesuit's college, governor's residence, many private palaces, and a modern *palazzo* containing a museum, library, and theatre. It is surrounded by old walls and towers, and contains a citadel. Its harbour is defended by two forts, and is frequented by coasting vessels. Pop. 13,000.

ASCOLIA, a festival celebrated by the Athenian husbandmen in honour of Dionysus (Bacchus).

ASCOLIASMUS, an amusement with which the Athenians diverted themselves during the Anthesteria and other festivals of Bacchus, to whom they sacrificed a he-goat, because that creature is destructive to vines; and after inflating its skin and smearing it with oil, they attempted to dance upon

Asconius || Ashantee.

it, thereby occasioning much merriment among the spectators. Virgil alludes to this custom:

inter pocula læti,
Mollibus in pratis unctos saliêre per utres. Georg. ii. 384.

ASCONIUS, Q. PEDITANUS, a Roman of the time of Vespasian, who wrote a good commentary on the orations of Cicero, a fragment of which was recovered by Poggio Bracciolini, when he attended the Council of Constance in 1416; but the MS. has again disappeared. Other fragments have been recovered by Mai. The best edition of Asconius is that of Orelli, Zurich, 1833.

ASCRIPTICII, in *Roman Antiquity*. See ACCENSI.

ASCRIPTITII, or ADSCRIPTITII, a kind of serfs, so annexed to the lands that they may be transferred and sold with them. Adscriptitii is sometimes also used in speaking of aliens or foreigners newly admitted to the freedom of a city or country.

ASDRUBAL, the name of several Carthaginian generals. See CARTHAGE.

ASELLIO, GASPARO, a physician of Cremona, born in 1581, who was afterwards professor of anatomy at Pavia. He is best known by his important discovery of the *Lacteal Vessels*. His treatise (*De lactibus*, Milan, 4to), on this subject was posthumous; being published in 1627, a year after his death.

ASH-WEDNESDAY, the first day of Lent, supposed to have been so called from a custom in the church of sprinkling ashes on the heads of penitents then admitted to penance. The primitive church did not commence Lent until the following Sunday: the present commencement was instituted by Pope Felix III., A.D. 487.

ASHANTEE, a country in Western Africa, in the interior of the Gold Coast. The Ashantee empire, including the numerous districts at that time entirely reduced under its control and jurisdiction, was considered by M. Dupuis as extending from Lat. 5. 0. to 9. 0 N., and from Long. 0. to 4. 0. W., comprising a space of about 50,000 square miles, inhabited by 3,000,000 of people. The original Ashantee, however, is not supposed to include more than a third of this large territory.

History of the Ashantee empire.

Tradition represents the Ashantees as deriving their origin from numerous bands of emigrants, who, two or three centuries ago, were driven before the Moslem tribes migrating southward from the countries on the Niger and Senegal. The Ashantees having occupied and cleared a region before covered with almost impenetrable forests, defended themselves with a valour which became part of their national character, and which raised them from a band of fugitives to the rank of a powerful and conquering nation. They even subdued and reduced into vassalage several of the Moslem tribes by whom they had been formerly supplanted.

Early in the eighteenth century the Ashantees first came under the notice of Europeans, through the successful wars in which they engaged with the kingdoms bordering on the maritime territory. Sai Tooto may be considered as the real founder of the Ashantee power. He either built or greatly extended and embellished Coomassie, the capital; he subdued the neighbouring state of Denkera, and the Mahometan countries of Gaman and Banna, the latter of which has been called the right arm of Ashantee; and extended the empire by conquests both on the east and west. His successor made further acquisitions of territory towards the coast.

In 1800 the throne was mounted by Sai Tooto Quamina, who soon showed himself animated by a peculiar spirit of enterprise and ambition. He appears early to have formed a desire of opening a communication with white nations, and of improving his country by the introduction of their arts and knowledge. Occupied, however, by wars and insurrections, he could not for some time turn his views in that direction. About 1808, however, a dispute arose among the chiefs of Assin, which in spite of the king's efforts at conciliation ended in an open rupture. The insurgent forces were defeated with great slaughter, and the chiefs compelled to seek refuge among the Fantees, the ruling people on the coast. The king's overtures of accommodation being again slighted, he determined to make the rebels and their protectors feel the weight of his vengeance. The allies found themselves wholly unable to resist the torrent of invasion; the country was laid waste with fire and sword, and they were driven with dreadful slaughter towards the coast. At length the fugitives reached the town of Anamaboe, where there was then a British fort. The governor exhorted the Anamaboes to endeavour to make pacific arrangements with this powerful enemy, and offered his mediation; but the citizens, falsely confident in their own strength, resolved to abide the contest. The result was the complete destruction of the town, with great slaughter among the inhabitants. The attempts of the Ashantees, however, to storm the English fort were unsuccessful, though the skill of their fire reduced the garrison, originally amounting to 24, to the number of 8 men fit for service. A truce was concluded, and the king having refused to make any terms except with the chief governor of Cape Coast, Colonel Torranne, who filled that office, at once repaired to Anamaboe. He was received by the Ashantee monarch with great pomp, and the result of their interview was a treaty by which the whole territory of Fantee, including Cape Coast itself, the capital, was ceded by right of conquest to the Ashantee empire. The governor took a still more questionable mode of securing the favour of this great potentate, delivering up to his mercy the two chiefs with whom the war had originated. The one effected his escape; the other was put to death with cruel ignominy.

Negotiations and war with the English.

The British government, actuated by very enlightened views, felt a wish to cultivate the alliance of this monarch, and to open a direct communication with him. They thus hoped not only to secure his friendship and commerce with his territories, but to obtain extensive information respecting the interior of Africa. In 1817, Messrs James, Bowdich, and Hutchison, departed on a mission to Coomassie. On their arrival they were received with dignified politeness, and invited to a public audience in the market-place. After one or two harmonious interviews, the king introduced the subject of certain sums which the British were bound to pay to the native governments, for permission to hold fortified factories. These sums the Fantees, as the ruling people on the coast, had been accustomed to receive; but the king, as having conquered the whole Fantee territory, claimed them now as due to himself. Mr James, who had come unprovided with any instructions to meet this apparently legitimate claim, simply replied that he would refer for instructions to the government at Cape Coast Castle. The king, who conceived that they came, as he said, "to make peace and settle all palavers," on finding them wholly unprepared to enter on what he viewed as the main object of discussion, broke out into an uncontrollable rage; called them cheats and liars; then started from his seat, bit his beard, exclaiming, that had a negro brought such a message he would have cut off his head. On seeing matters come to this extremity, the two junior members of the mission, Messrs Bowdich and Hutchison, conceiving that Mr James, by blind and obstinate adherence to rule, was endangering the English interests, and perhaps even the safety of the mission, took the negotiation into their own hands. They conducted it in a manner altogether satisfactory to the king: a treaty was concluded, by which all his demands were satisfied; and, after a residence of several months, they returned to Cape Coast.

The government at home, though they demurred somewhat to the very irregular course pursued by Mr Bowdich and his companion, saw the wisdom of cultivating an inter-

Ashantee.

course with this powerful African court. They determined to station at his court a fixed resident, and nominated to that station M. Dupuis, who had long filled with credit the important post of British consul at Mogadore. The new consul arrived at Cape Coast in January 1819. By that time a complete and unfortunate change had taken place in the views of the British local government. They had been gained entirely over to the interest of the Fantees or coast natives, who were constantly on the spot, and possessed eloquence, talents, and address. An insurrection had arisen in the interior of the Ashantee monarchy, respecting which the most exaggerated rumours were spread and listened to with blind credulity. Insulting messages were sent to the king, who was also informed that the natives of Cape Coast were setting his authority at open defiance, and were forming a wall to defend the town. Under the views which he had formed, the governor, on various pretences, prevented M. Dupuis for some time from proceeding on his mission; but on the arrival of more than one ambassador from the king, demanding reparation for the wrong committed against him, it was thought prudent that he should proceed to the court of Ashantee.

M. Dupuis set out on the 9th February 1820, and on the 28th arrived at Coomassie. He seems to have proceeded very judiciously, and in a manner at once firm and courteous; and after several confidential meetings with the king, a treaty was drawn up, which adjusted satisfactorily all the differences between the two parties. The king dismissed M. Dupuis with many marks of esteem and kindness, sending along with him two natives of distinction, to proceed as ambassadors to England, with a present of two beautiful leopards.

On his return to Cape Coast, he was deeply disappointed to find that the governor altogether disowned the treaty, representing it as having betrayed British interests, and as having wantonly transferred to Ashantee the sovereignty of the Gold Coast. At the same time the Fantee party persuaded Sir George Collier to refuse transporting to Britain the ambassadors sent by the king of Ashantee; conduct which could not but be in the highest degree offensive to that monarch.

M. Dupuis returned to England to represent the particulars to the government; but an entire change meantime took place in the administration of the British affairs in Africa. The African Company were induced to resign the command hitherto held by them over the forts, which were taken entirely into the hands of the crown. The first step adopted in consequence, was to invest Sir Charles M'Carthy with the general government of all this range of coast. The new governor arrived early in 1822; but though he had communicated with M. Dupuis, who earnestly endeavoured to impress him with his own ideas of African politics, Sir Charles soon implicitly adopted the principles and policy of the Fantee natives. He placed the town in a posture of defence, and formed alliances with all the neighbouring tribes, who ranged themselves under his standard. The dreaded conqueror of the Gold Coast appears to have died during the summer of 1823, and it was hoped that the hostile attitude exhibited by the English would overawe his successor. He, however, was already busied in warlike preparations. At length a negro serjeant in the English service was seized in the great square of Anamaboe, on pretext of some injurious expressions respecting the king; and after being detained for six weeks, seemingly in expectation of some negotiation being opened for his release, was beheaded at Donqua. The king now declared open war, summoning all his vassal princes, and calling upon them "to arm against Britain, even to the fishes of the sea." Yet at this very time he made overtures through the Dutch government at Elmina, who had always prudently cultivated his alliance; but these were deemed unworthy of answer.

It behoved now the English to meet in the field the formidable enemy whom they had provoked, and taken no pains to appease. In their first encounter, a reconnoitering party under Captain Laing defeated a body of the enemy; but the rash confidence thereby engendered soon after received a dreadful blow by the utter rout of the British force of 1000 men, near the boundary stream of the Prah, by a native army of about 10,000 men. The ill-fated commander, Sir Charles M'Carthy, is supposed to have perished in the disastrous attempt to retreat. Only fifty men, including two officers, Major Ricketts and Lieutenant Erskine, returned to the castle. All the rest, among whom were the chief civil functionaries, paid the penalty of their rash counsels.

The Ashantee army now marched upon Cape Coast, laying waste the country with fire and sword. At that place, however, the detachments of Major Chisholm and Captain Laing had united with the wrecks of the main corps, and prepared for defence with the characteristic vigour and courage of English troops. The king, flushed with victory, made repeated and desperate assaults, but at last sustained a signal defeat, on the 7th August 1826. He was then obliged to purchase peace at the price of 6000 ounces of gold, and to send his son as a hostage to Cape Coast Castle. Since this event, the Ashantee power on the coast has become extinct, and its limits are now many miles distant from the sea.

Recent events.

By the treaty concluded at the end of the war, the river Prah was fixed as the boundary of the Ashantee kingdom, and all the tribes to the south of it were placed under the British protection. Till within a comparatively recent date, this treaty was duly respected by the kings of Ashantee. Towards the end of 1852, however, decided symptoms were evinced of a disposition on the part of the Ashantee monarch to interfere with the states which this treaty had absolved from his jurisdiction. Two Assin chiefs, Chibbu and Gabri, who had in the time of the war revolted from Ashantee and joined the Fantee alliance, were discovered to be intriguing with the king of Ashantee, who had paid them 400 ounces of gold as the price of their meditated treason. According to the plan concerted, the king was to make a visit to Donqua for the purpose of making "custom" for the late chief of Denkera (who had formerly been a vassal of Ashantee), the pretext for an armed aggression of the Assin territory. With this view he had crossed the Prah with a force of about 7000 men. These warlike movements naturally excited much uneasiness at Cape Coast Castle, and for a period of some months no effort was spared by the British authorities to bring matters to a pacific settlement, while an armed force was at the same time held in readiness to meet the aggressors. It is satisfactory to know by the last despatch of Governor Hill to the Colonial Secretary (dated April 26. 1853), that the negotiations had proved so far successful, that the Ashantees had retraced their steps across the Prah, giving considerable hopes that war is for the present averted. The two chiefs, who had been found guilty of treason, had before this been publicly beheaded on the 18th April 1853, after a regular trial by the allied chiefs and the captains of Assin.

Present state of Ashantee.

Ashantee proper, comprising about 14,000 square miles, and a million of inhabitants, presents a dense and almost impenetrable forest, the routes through which consist merely of narrow winding tracts, in which, though it is possible for a man to ride, or a palanquin to be carried, no waggon of any description could pass. The interior country round the towns, however, is cultivated with diligence, the fields being kept very clean, and yielding in abundance grain, yams, vegetables, and fruits. The territory yields also a considerable quantity of gold; and that precious metal is brought in still greater abundance from the regions farther to the north, particularly Gaman, where it occurs not merely in the usual form of gold dust, but in pretty large fragments, mingled in

pits with rock and gravel. It is even said that, but for a superstitious idea, which induces the natives to leave the largest deposits untouched, the produce might be much more ample. The Ashantees are skilful in several manufactures, particularly in the great African fabric of cotton, which they weave with a loom of simple and rude construction. Their pottery and works in gold are also skilful, though surpassed by those produced in the more southern countries.

The government of Ashantee forms a mixture of monarchy and military aristocracy; the lower orders being held in the most complete thraldom, and liable either to be put to death or sold into slavery at the will of the chiefs. The king carries on all the ordinary administration of the state; but in questions relating to peace or war he is bound to consult the council of the caboceers or captains, which M. Dupuis calls a senate. Each of these caboceers keeps a little court, where he gives audience, and makes a profuse display of barbaric pomp. Polygamy is indulged in to an enormous extent. The king has a regular allowance of 3333 wives; but in Africa these princesses are employed variously, as guards, messengers, and even in the humblest services. The crown, as often happens in barbarous countries, descends to the king's brother, or sister's son, not to his own offspring.

The Ashantee monarchs, though so extremely ambitious, appear to pay considerable regard to the faith of treaties, seeking always a plausible ground of war; and, even when justly provoked, not usually commencing it without previous overtures of negotiation. The barbarous and capricious governments, however, by which they are surrounded, jealous of the Ashantee power, without duly measuring their own strength, afford frequent cause of justifiable invasion.

The darkest feature in the Ashantee character is visible in the dreadful system of human sacrifice. It is founded on a wild idea of filial and relative piety, which makes the chiefs fancy it their duty to water with blood the graves of their ancestors, whose rank in the future world will, they imagine, be measured by the number of attendants thus sent along with them. There are two fixed annual periods called the great *Adai* and little *Adai*, at each of which human victims are immolated to a monstrous extent. Still more dreadful is the custom celebrated after the death of the king, or any member of the royal house. When Mr Bowdich was at Coomassie, the monarch, in honour of his mother, had sacrificed no less than 3000 victims. These are chiefly prisoners of war or condemned criminals. British influence, however, seems to have diminished this shocking practice.

ASHBOURNE, a market-town in the hundred of Wirksworth, and county of Derby, near the river Dove. It contains a large church of the thirteenth century. The manufactures are cotton, lace, iron, &c. A good corn-market is held here every Saturday. Pop. in 1851, 2418. Distance from London 139 miles.

ASHBURTON, a borough and market-town of England, in the hundred of Teignbridge and county of Devon, 192 miles W.S.W. of London, and 18 S.S.W. of Exeter. It stands in a valley surrounded on every side by hills, at a short distance from the river Dart, and consists principally of one long street on the high road between London and Plymouth. The church of St Andrew is a handsome Gothic structure, built in the form of a cross, with a tower ninety feet high. Ashburton has a bank, three chapels, a free grammar-school, with an exhibition and two scholarships at Exeter college, Oxford, and numerous charities. It is the seat of one of the stannary courts; and previous to the Reform Act, it returned two members to parliament, but now only one. Population in 1851, 3432, principally employed in the manufacture of serge, or in the tin and copper-mines and slate-quarries in the vicinity. This was the birthplace of the celebrated lawyer Dunning, who was created Baron Ashburton, and of William Gifford, the original editor of the *Quarterly Review*.

ASHBY-DE-LA-ZOUCH, a market-town of England, county of Leicester, and hundred of West Goscote, 17 miles north-west of Leicester. The town consists principally of one long street, and contains two churches, four chapels, a bank, savings-bank, theatre, and gas-works, and has a grammar-school, with ten exhibitions of L.10 each per annum in Emanuel College, Cambridge, besides several charity schools. The Ivanhoe baths, erected in 1826, are much frequented for their saline waters, which, as containing bromine, are found useful in scrofulous disorders.

The church of St Helen is a fine old building, containing the tombs of the Huntingdon family, and a "finger pillory." In the vicinity are the extensive remains of Ashby Castle, built by Sir William Hastings in 1480, and in which Mary Queen of Scots was confined. Population in 1851, 3762, principally engaged in the manufacture of stockings, hats, firebricks, or in the coal and iron mines of the vicinity. Bishop Hall was a native of this place.

ASHDOD. See AZOTUS.

ASHES, the fixed residue of combustible substances after they have been burnt.

ASHES were used in many ancient religious ceremonies. St Jerome relates that the Jews in his time rolled themselves in ashes as a sign of mourning. To repent in sackcloth and ashes is a frequent expression in Scripture for mourning and being afflicted for our sins. A heifer being sacrificed upon the great day of expiation, its ashes were distributed among the people, who made from them a sort of lustral water, which they sprinkled on such persons as had defiled themselves by touching a dead body or being present at a funeral (Numb. xix. 17).

The ancient Persians punished some great criminals by throwing them headlong down a tower filled with ashes to a particular height (2 Macc. xiii. 5, 6).

ASHFORD, a market-town of England, county of Kent, and hundred of Chart, 12 miles south-west of Canterbury, and 53 from London. It is pleasantly situated on a gentle eminence near the junction of the upper branches of the river Stour, and is a chief station of the South-Eastern Railway. Many of its houses are well built and handsome, and its principal street is nearly half a mile in length, and well paved and lighted. It has a fine old Gothic church, with a lofty well-proportioned tower, and many handsome monuments; four chapels, two banks, a savings-bank, market-house, assembly-rooms, a four-arch bridge over the Stour, and a free grammar-school founded by Sir Norton Knatchbull in the time of Charles I. Pop. in 1851, 4092.

ASHI, commonly called ASSER, the author of the Babylonian *Talmud*, was born at Babylon in 353. He is said to have given very early proofs of his acquirements. The Talmud is the expositions of the *Mishna*, delivered by him to his pupils in the Jewish College. He died in 426.

ASHLAR, a term used among builders for common or free stone roughly squared in the quarry. This term is likewise applied to different kinds of surfaces produced by tooling; hence we have axed, tooled, grooved, chiselled, and rusticated ashlar.

ASHMOLE, ELIAS, an English antiquary of the seventeenth century, was the son of a saddler in Lichfield, and was born on the 23d of May 1617. He went to London at the age of 16, and resided in the family of his uncle, James Paget, Esq., one of the barons of the exchequer, and then turned his attention to the law and various branches of literature. In the year 1638 he married, and commenced the business of attorney in London. When the civil war began, being then a widower, he entered into the king's service in the ordnance department. When residing in the

city of Oxford in that capacity, he entered Brazen Nose College, and began the study of natural philosophy, mathematics, and astronomy. Naturally inclined to grave and scientific trifles, he wandered into the wilds of astrological imposture, which was not a little encouraged by several eminent men of that age. From the same cause he entered keenly into the secrets of masonry, and made considerable additions to the history of that fraternity. From Oxford he removed to Worcester, where he was appointed commissioner of the excise; and soon after he became a captain in Lord Ashley's regiment, and comptroller of the ordnance.

When Worcester was surrendered to the parliament in 1646, Ashmole retired to London, where he became acquainted with the famous astrologers, Moore, Lilly, and Booker. Having removed to Berkshire in the year following, he added the knowledge of botany to his other acquirements. There he became acquainted with Lady Mainwaring, a well-jointured widow, whom he married in 1649; and although her estate was sequestrated on account of his loyalty, yet through the interest of Lilly and others he again recovered it, and afterwards settled in London, where his house became the resort of all the curious literati. A taste for chemistry, or rather alchemy, was produced by his conversation with William Blackhouse; and Ashmole, under a feigned name, published a work upon that subject. The next effort of his industry was a collection of the manuscripts of English alchemy, which he published under the title of *Theatrum Chymicum Britannicum*, in 4to.

His active industry was next directed to the study of antiquity and the investigation of records. Along with Sir W. Dugdale, he traced about this period a Roman road to Lichfield. Abandoning all other pursuits, he began to make preparations for his *History of the Order of the Garter*. Upon a visit to Oxford, he gave a full description of the coins bequeathed to that university by Laud; and about this time John Tradescant, the famous gardener of Lambeth, presented him with the collection of curiosities which both he and his father had procured.

On the Restoration, Ashmole came into high favour with the king, who made him Windsor herald, and employed him to give a description of the royal medals. The offices of commissioner and comptroller of excise were conferred upon him; and being called to the bar in the Middle Temple, he was afterwards admitted a fellow of the Royal Society. The university of Oxford conferred upon him the degree of doctor of physic; and several other employments and emoluments flowed in upon him. About this time his second wife died, and he married the daughter of his friend Sir W. Dugdale. In May 1662 he addressed his great work to the king, entitled *The Institution, Laws, and Ceremonies of the most noble Order of the Garter;* folio, London, 1672. In favour of his brother-in-law Mr Dugdale, he resigned his office of herald of Windsor; and when offered the office of garter king-at-arms, he declined it in favour of Sir W. Dugdale. About this time a fire broke out in one of the chambers of the temple adjacent to his, and consumed a library which he had been collecting during the course of 33 years, together with 9000 coins and many valuable antiquities; but his manuscripts and gold medals were fortunately saved. In 1683 he sent his manuscripts and curiosities to the University of Oxford, which laid the foundation of the *Musæum Ashmoleanum*, still in Oxford. On the death of Sir W. Dugdale, he refused a second time the office which that gentleman had enjoyed. He died at the age of 76, and was interred in the church of Great Lambeth.

ASHOVER, a town and parish in Derbyshire, containing 3482 inhabitants.

ASHRAFF, or USHRAFF, a decayed town of Persia, in the province of Mazunderan, about 8 miles from the western extremity of the bay, and 52 miles west of the city of Astrabad. It was formerly a very extensive city, and the favourite residence of Shah Abbas, the greatest of the Persian monarchs, who erected here a magnificent palace, now in ruins. It is said to have formerly contained 300 baths; but now it has not above 500 houses, which are thinly scattered through an extensive jungle. Lat. 36. 41. N. Long. 53. 32. E.

ASHTAROTH, and ASHTAROTH-CARNAIM, a town of Bashan (Deut. i. 4; Josh. ix. 10). It is now usually identified with Mezareib, which was built about 350 years ago by the Sultan Selim, and consists of a castle and store-houses to supply provisions to the pilgrims on their way to Mecca. On an elevated spot at the extremity of a promontory advancing into the neighbouring lake, stands a sort of chapel, around which are many ruins of ancient buildings.—Buckingham's *Arab Tribes*.

ASHTORETH, ASHTAROTH, or ASTARTE, in *Antiquity*, a goddess of the Sidonians, and also of the Philistines, whose worship was introduced among the Israelites during the period of the Judges (Judg. ii. 13; 1 Sam. vii. 4), and celebrated by Solomon himself, in compliment to one of his wives. In the reign of Ahab, Jezebel caused her worship to be performed with much pomp and ceremony; she had 400 priests; the women were employed in weaving hangings or tabernacles for her; and Jeremiah observes, that "the children gathered the wood, the fathers kindled the fire, and the women kneaded the dough, to make cakes for the queen of heaven." The best etymology of the word, and that approved by Gesenius, deduces it from the Persian *sitârah, star*, with a prosthetic guttural. Ashtaroth is the plural form, which, perhaps, denoted a plurality of images (like the Greek Ἑρμαί), or it was used as the *pluralis excellentia* among the Hebrews in words denoting "lord." Most modern scholars assume that Ashêrah was another name for Ashtoreth, whose worship has been identified with that of the Greek Aphrodite, which was introduced into Cyprus from the East.

ASHTON-UNDER-LYNE, a parliamentary borough in the county of Lancaster, hundred of Salford, and diocese of Manchester, on the northern bank of the river Tame, 6½ miles east of Manchester, and 197 north-west by north of London. The town is well built, containing many tasteful villas and handsome public edifices. It has three large churches; eleven dissenting chapels; a spacious town-hall; a good market-house; three banks; a savings-bank; a theatre; a mechanics' institute; with many week-day and Sunday schools. To supply in some respects the want of dispensaries and infirmaries, the working classes unite in paying a few pence weekly to a common fund, from which medicines are purchased, and the services of experienced medical men secured for their families. At a short distance to the north of the town are the infantry and cavalry barracks, erected in 1843 at a cost of L.42,500; and the union workhouse, erected in 1851 at an expenditure of L.12,000. Since the introduction of the cotton trade in 1769, this place has rapidly risen into importance. It enjoys many facilities for manufacturing industry, from coal being very plentiful in the neighbourhood, from three important railway lines passing through it, and from its being united by canals with Manchester, Huddersfield, and Derbyshire. In 1821 it had a population of only 9222, which in 1851 had increased to 29,798, chiefly engaged in spinning cotton yarn and weaving calico pieces by machinery in the numerous large factories. This town is of great antiquity, and still exercises many of its ancient feudal customs and manorial privileges. It is divided into four wards, governed by a mayor, eight aldermen, and twenty-four councillors; and since the Reform Act returns one member to the House of Commons. Market-days Tuesday and Saturday, and fairs on the 23d March, 29th April, 25th July, and 21st November.

ASIA.

Asia.

This division of the globe is distinguished by its vast extent; by the striking character of its interior geography; above all by the stupendous revolutions of which it has been the scene; and, lastly, by the high antiquity of its civilization, of which we can still faintly trace the precious remains. Stretching from the southern hemisphere into the northern regions of perpetual winter, it comprises within its bounds the opposite extremes of heat and cold; all the varieties consequently of the animal and vegetable tribes; and that still more interesting variety which the irresistible law of climate impresses on the human species. The surface of Asia, towering to its height far above the regions of perpetual snow, presents, when superficially examined, a confused mass of lofty mountains, diverging into an endless variety of inferior ridges, apparently without plan or system. But a more attentive survey discloses, amid the bold irregularities of nature, the same order and unity of design in the structure of this great continent, as in all the other works of creation.

Asia was the earliest abode of the human race; and, when all the other parts of the world were either uninhabited or sunk in barbarism, it was the seat of great empires and of flourishing and splendid cities, of commerce, of literature, and of all the arts of civilized life. But its early prosperity was blighted by the ruthless devastations of war; its populous cities were utterly destroyed, so that the spot on which many of them stood is now only marked by masses of ruins; their arts and literature have perished; and in such fragments of their writing as still survive, the meaning is buried under the almost impenetrable veil of an ancient and unknown character. In touching on the various topics which are comprehended under the designation of Asia, it must be remembered that in the following article we are to confine our attention to such general views of its geography, history, institutions, policy, and manners, as will not supersede a more particular description of its various states under their respective designations.

Name.

The name of Asia was at first applied by Homer and others of the ancient poets and historians to a small district of Lydia, occupied by a tribe called Asiones, who inhabited a city of the name of Asia. The Greeks, gradually enlarging their discoveries in those eastern countries, still retained the original name, until it embraced the whole of Asia Minor and the countries to the east; and it was at last applied to all the vast regions which subsequent discoveries have brought to light.

Limits.

The limits of Asia are in some cases marked out by nature, and admit of no dispute; in other parts they are not very clearly defined, and have been differently settled by geographers, according to their own notions of propriety or distinctness.

The continent of Asia extends over 77 degrees of latitude, or one-fifth of the periphery of the globe, and in the latitude of the Dardanelles, over 128 degrees of longitude, or very nearly one-third of the circumference of the globe under that circle. Its northernmost extremity is Cape Chelinskin, which projects into the Arctic Ocean in about N. Lat. 78°, in Long. 100° E. In the S. it extends to N. Lat. 1. 15. at Cape Bulus or Buro, or the S. end of the peninsula of Malacca; but if we include the Indian islands, Asia extends as far as S. Lat. 11°, or the parallel of Rottie, a small island to the S.W. of Timor. Its continental extremity in the W. is Cape Baba, in Asia Minor, opposite the island of Mytilene, in E. Long. 26. 4.; and its easternmost point is Cape Wostotchny, or the "East Cape," also called Cape Swernoi Tchukotsky, that is "the North Cape of the Tchuktches" (who call it Po-orten), and which must not be confounded with Cape Tchukotsky Noss, the latter lying more to the S. The continent of Asia is bounded in the N. by the Arctic Ocean, in the E. by Behring's Strait, which separates it from America, and by the Sea of Kamtschatka, the Sea of Okhotsk, the Sea of Japan, the Yellow Sea, and lastly, the Tong Haï, or East Sea. But the Japanese and several other groups of smaller islands, being appurtenances of the continent, it is evident that the North Pacific Ocean is the real eastern boundary of Asia. The southern limits are the Chinese Sea, the Strait of Malacca, the Gulf of Bengal, the Arabic Sea, the Gulf of Oman, and the Gulf of Aden; the latter four being limbs of the Indian Ocean The great Indian islands, the Philippines, Borneo, Sumatra, Java, Celebes, the Spice and Sunda islands, and all those smaller ones which, dotting the Sea of Banda, extend as far as the shores of New Guinea, are now generally reckoned to Asia, with which, indeed, they are so intimately connected by ethnological, religious, commercial, and political ties, that we are bound to consider them as appurtenances of that great continent. Asia consequently extends in the S.E. to the very threshold of Australia, or Oceania, but there are no natural limits separating them into two distinct portions of the globe. In physical geography, all or most of those islands form one vast volcanic group with the other islands along the east coast of Asia, the peninsula of Kamtschatka included. The limits of Asia in the W. are, the Red Sea, which separates it from Africa, the Mediterranean, the Dardanelles, the Sea of Marmora, the Bosphorus, and the Black Sea, on the side of Southern Europe; and the Ural and the Caucasus on the side of Eastern Europe. Between the Ural and the Caucasus there is a gap without natural limits, the great steppes of Western Asia advancing here into Eastern Europe; whence some geographers, in their eagerness to find natural limits where there are none, have substituted divers inconsiderable inequalities of the ground to serve as lines of demarcation between two large portions of the globe. But the Caucasus *is* a natural barrier, and if the plains to the N. of that great chain bear an Asiatic character, and are inhabited by Asiatic people, which cannot be denied, it is equally true that the steppe in its progress from E. to W. gradually assumes a European character, inasmuch as from a salt steppe, such as in Turkistan, it changes into a grass steppe, such as in the S. of Russia; and so far as regards the Asiatic character of the people, the influence of Europe through Russia is so great, that that difference also has all the appearance of being on the wane. The river Jaïk or Ural, between the Ural Mountains and the Caspian, affords a convenient line of demarcation on that side; not that it is a natural limit between two continents, or that the steppe on its right bank differs from that on its left; but because that river has been turned by the Russian government into a visible, fortified, and garrisoned line between various nations living under European influence in the W., and uncontrolled Asiatic barbarians in the E This view of the subject will be our excuse, if we refrain from saying much about the Obtchey Sirt, a ridge of low sand-hills between the southern foot of the Ural and the Wolga, marking the northern edge of the steppe, which some geographers have called a natural boundary, to fill up the gap on that side. It is worth noticing, that in the political division of Russia, no distinction is made between Europe and Asia, some of its governments, as for instance that of Perm, extending over both sides of the Ural Mountains.

Extent.

Asia contains a larger area than any of the other divisions of the globe, viz., including its islands, 12,960,000 square geographical miles; the area of America being 10,600,000, that of Africa 8,550,000, and that of Europe 2,560,000.

Asia. Islands.

The islands of Asia are:—in the Arctic Ocean, Nova Zembla, consisting of two large islands, and New Siberia, consisting of three islands of considerable extent discovered in the course of this century. Along the E. coast:—the volcanic group of the Kuriles; the Japanese islands, of which Nipon is the principal; the Lu-ku group to the S. of Japan; the large islands of Formosa and Hainan on the coast of China. Saghalia, opposite the coast of Mantchuria, was long believed to be an island, but is a peninsula extending over 8 degrees of latitude, and connected with the continent by a low, narrow, and sandy isthmus, a little to the S. of the mouth of the River Amur. In the S.E. and S.:—the Philippines, among which Luzon and Magindanao are the largest, and half a dozen others have areas surpassing or approaching those of Cyprus and Candia; the great islands of Borneo, Sumatra, Java, and Celebes; the Moluccas or Spice Islands, among which Gilolo, Ceram, Buro, and Amboyna, between Celebes and New Guinea; Nias, Batu, the two Pora, &c., on the W. coast, and Battam, Linga, Banka, and Billiton, on the E. coast of Sumatra; and, finally, the Sunda and Banda islands, a vast latitudinal archipelago, extending from the E. point of Java towards Australia and New Guinea, and composed of myriads of islands, among which the principal are in a direction from W. to E.; Madura, Bali, Lambok, Sumbava, Sandelbosh or Tshindana, Flores, Timor (250 miles long), Timor Laut, and Aru, which form a bridge as it were between Asia and Australia. In the Indian Ocean:—the Nicobar and Andaman Archipelagos, between the N.W. point of Sumatra and the mouths of the Irawaddy; the large island of Ceylon; and, on both sides of the 70th meridian E., stretching due N. from S. Lat. 8° nearly as far as the latitude of Goa, the archipelagos of the Tshagos, Maldives, and Lakkadives, all three composed of myriads of mostly very small islands of coral formation. In the Persian Gulf:—Ormuzd, Kishm, and Bahrein. In the Red Sea:—Perim, Arish (erroneously called Harnish), Farsan, and Dhalak. In the Mediterranean:—Cyprus, Rhodes, Chios, &c.

Physical aspect.

The surface of this vast continent is exceedingly varied. In some places it towers in stupendous mountains, forming four great chains, with subordinate branches, of different names. It often exhibits vast plateaux or elevated tablelands, of prodigious extent; in other points it stretches in plains little elevated above the level of the ocean; while in certain points it presents enormous hollows or depressions that are lower than the surface of the Black Sea. Humboldt computes the superficies of all Asia at 1,346,000 geographical square leagues. Of this a large proportion is mountainous, or raised in elevated plains. The same eminent authority estimates these as follows:—

	Sq. leagues.
The mountainous parts of Arabia, Beluchistan, or the plateau of Kelat, Kandahar, with the mountain ridges of India	240,000
The mountainous parts of China	54,400
The plateau of Gobi or Sha-mo	42,000
The plateau of Tibet and Ladak, between the Himalaya and Kuen-lun Mountains	41,000
The plateau of Persia	27,000
The Taurus of Asia Minor, Ararat, and the Hindu Kho	81,300
Of which that of Ararat alone is	3,500
The Caucasus, from Baku to Anapa	2,700
The Oural and Altai groups	3,400

The northern portion of Asia consists of a series of plains divided by mountains of small elevation, forming the comparatively low land of Siberia, intersected by several large rivers, and occupied often by extensive swamps. This region is estimated at about 400,000 square leagues. The central part of Asia, still imperfectly known to Europe, was till lately conceived to be one vast table-land, of irregular form, buttressed on every side by lofty mountains; but it now appears, on the contrary, to be traversed by long mountain chains.

Asia presents to the eye such a compactness of conformation, and its outlines are at the same time so diversified by deep indentures of the sea, forming gulfs and peninsulas of every shape and dimension, that neither Africa can be called more compact, nor North America more diversified. Every prominent feature of this vast continent is on a gigantic scale; and the aggregate of its mountains and rivers, its low plains and its elevated plateaux, surpasses those of the other divisions, not only in magnitude, but also by its contrasting variety.[1] Its mere steppe rivers approach the size of the Don and the Dniepr; and the second of its salt lakes, the Aral, is still larger, by 6400 square geographical miles, than Lake Superior, the largest sheet of water in America; while the combined superficies of all the American lakes would not suffice to cover the area of the Caspian. Its Indian Archipelago forms a world by itself, with which the West Indian Islands can be compared neither for extent nor importance; its mountains rise higher into the regions of eternal snow than the far-famed Chimborazo; it has its deserts of burning sand, and of frozen swamps, alike destructive to the human race. Nowhere is there such an exuberance of animal and vegetable life, not only spread over the whole continent, but also displaying itself within the narrowest limits, as the traveller rapidly descends from the crest of the Himalaya into the plain of Bengal. The same variety, the same contrasts, appear in its history. Asia, the cradle of mankind, the mother of religion, the nurse of civilization, where arts and letters were cultivated in the remotest times, contains within her inaccessible mountain forests numerous descendants of her primitive inhabitants, who still continue that brutish life which their forefathers led when the first vine was planted, the first hieroglyphic character carved in the rock.

Divisions.

Nature has divided Asia into six portions, of which each is so vast and so distinct from the other as almost to present a world by itself. These are Central, Western, Northern, Southern, Eastern, and Oceanic Asia. We place Central Asia at the head, because it is not only the nucleus of the whole continent, comparable to a huge citadel situated in the centre of a fortress, of which the other divisions are the bastions and ramparts, the peninsulas and islands the outworks; but also because the nations by which it is inhabited have exercised, from the remotest times, a most powerful influence on those of the other divisions, so that most of the great revolutions by which Asia has from time to time been convulsed since the very dawn of history, and which affected even Europe in such a degree as to change the whole ethnographical and political aspect of that continent also, can be traced back to commotions among the forefathers of those barbarous tribes of shepherds, who still wander in the cold and dreary steppes over which the Bogdo Ula towers in awful, majestic solitude.

Central Asia.

Central Asia, the greatest and highest table-land on the globe, extends between the Himalaya in the S., which se-

[1] According to Berghaus, there are 10 rivers in America, and 12 in Asia, the basin of each of which contains upwards of 10,500 German, or 168,000 geographical square miles. The united area of the former, the first of which is the Amazon, and the last the Rio Negro, is 324,500 German, or 5,192,000 geographical square miles; of which the basin of the Amazon occupies not less than 2,018,400. That of the latter, the Obi standing at the head with 924,800 geographical square miles, and the Tarim being the last, is 363,738 German, or 5,820,000 geographical square miles; giving a difference of 628,000 geographical square miles in favour of Asia. The total length of the 10 American rivers, windings included, is 76,640 geographical miles; that of the Asiatic, 98,448 geographical miles: difference in favour of the latter, 21,808 geographical miles. Yet the system of the Marañon in the former stands unequalled by any in the world.

Asia.

parates it from India, and the chain of the Altaï, with its eastern continuation, the Daurian Mountains, in the N., towards Siberia. Its western boundary is the Bolor Dagh, a lofty range beginning at the Hindu Koh in E. Long. 72°, by which it is separated from Turkistan, and which stretches due N. as far as the steppes of the Khirgises, in about N. Lat. 46°. In the E. it is bordered by China and Mantchuria. From the junction of the Hindu Koh and the Bolor Dagh, a snowy range extends E. in the 35th parallel, as far as the Alps of Shensi, in China; its western portion, towards the Bolor Dagh, is called Thsun-ling; its eastern, Kwan-lun or Kuen-lun,—both names meaning Blue or Onion Mountains. From the Kuen-lun the Sive-shan and Amie Gangar Ula branch off N.E., towards the Lake Kuku-nûr. Another high range shoots from the central portion of the Bolor Dagh, N.E. and E., far into the interior. It is called Tengri Dagh by the Turks in those parts, Thian-shan by the Chinese—both of which names signify Celestial Mountains; and Mus Dagh, or Ice Mountains, by the Mongols. Separated from the Thian-shan by an intervening portion of the desert of Gobi, extends the snowy range of Gadshar or In-shan along the northern frontiers of China. The highest peak of the Thian-shan is the celebrated Bogdo Ula, or Holy Mountain, one of the loftiest mountains in Asia, at the western foot of which lies the volcano of Petshan.

Divisions of Central Asia.

The four chains of the Himalaya, the Kuen-lun, the Thian-shan, and the Altaï, are, in the whole, parallel to each other, and divide the table-land of Central Asia into three plateaux of decreasing elevation and different dimensions, namely, Tibet, High Tartary, and Mongolia.

First terrace, or Tibet.

The highest terrace is Tibet, between the Himalaya and the Kuen-lun, and the Bolor and China; between N. Lat. 28° in the extreme S., 36° in the N., and 39° in the extreme N.E.; and between E. Long. 68° and 98° from W. to E. Ladakh in the extreme W., Kham in the E., and Tangut in the N.E., are appurtenances of Tibet. The level of Tibet is not equal, its surface showing numerous and extensive depressions, with steppe rivers flowing into salt lakes without outlets; the valleys of the Indus, the Dzangbo and the Yang-tse-kiang (in Kham), especially that of the Dzangbo, are also much below the general level. The highest plateaux are around the culminating point of the Himalaya, the Hindu Koh, the Bolor Dagh, and the Kuen-lun, on the borders of Turkistan; and Ritter thinks that the plateaux around Lake Kuku-nûr are quite as high. Their elevation is not accurately known, but they are both higher than the plateaux stretching from the sources of the Sutledj E. towards the sacred mount Kaïlasa, which rise 16,800 feet above the sea, increasing in height further E. The average height of the other Himalaya plateaux is about the same. Mount Purkyul or Tashgong, on which Lieut. Gerard reached, in 1818, an altitude of 18,210 feet, is 21,300 feet high; but the highest known peaks of the Himalaya do not lie on Tibetan territory. According to all appearance the peaks which rise above the high table-land on the borders of Turkistan, and those around Lake Kuku-nûr, probably equal in elevation the highest peaks of the Himalaya. In Kham, also, which is intersected by numerous valleys encompassed by precipitous Alpine rocks, there are mountains of stupendous height, and mountain passes lying 18,000 feet above the sea, over which, however, the Chinese more than once penetrated into Tibet with armies of 100,000 men. The climate of Tibet is very severe, the winters being almost insupportable, but the summer season in the lower valley of the Dzangbo is genial, the country producing grapes, peaches, and other choice fruit, in abundance. Tibet contains the sources of the Indus, the Dzangbo, the Yang-tse-kiang, and the Hoang-ho, the latter two being in Tangut. The largest lakes, which are all surrounded by vast and excellent pastures, are Kuku-nûr in Tangut, and Tengri-nûr in Tibet Proper. Our scanty knowledge of Tibet has lately received a valuable addition in the journal of the Rev. Mr Puch, a French missionary, who proceeded from Peking, through Mongolia and Tangut, to L'Hassa, the capital of Tibet, which he left for China by the road through Kham. An English translation of his MS. journal was recently published under the auspices of Lord Palmerston.

Second terrace, or High Tartary.

The slope of this terrace, which comprises Chinese Turkistan, the western portion of the desert Gobi, and the southern portion of the Chinese government Kan-fu, is from the high plateaux of the Bolor Dagh E., towards the desert Gobi. Its highest tracts lie in the Bolor Dagh, the Thian-shan, especially around the Bogdo Ula, the Tsung-ling and Kuen-lun, and in the far E., in Kan-fu, along the snowy Tangut range, the slope of which towards the Gobi seems to be very rapid. There the province of Kan-fu penetrates edgewise into Mongolia, extending N. and W. towards the Altai Proper. The central and eastern portions of High Tartary are occupied by the southern Gobi, which lies much below the general level of the terrace. The elevation of this terrace is considerably lower than that of Tibet, as appears from the genial climate of Chinese Turkistan, which is said to produce grapes, pomegranates, peaches, and other choice fruit of southern climes. The river Ta-rim, swelled by numerous affluents descending from the Bolor, the Tsung-ling and the Kuen-lun, traverses the whole of Chinese Turkistan from W. to E., and empties itself into the steppe lake Lob, on the borders of the Gobi, after a course of about 1000 geographical miles. It is also called Erghö-göl, and Yar-kiang Daria, which, however, is but the name of a large southern affluent washing the walls of Yar-kiang. The natives and the Chinese contend that the Ta-rim was once connected with the Hoang-ho, of which it formed the upper course, but that the connection was interrupted in consequence of the level of the Gobi having been raised by volcanic power. Besides the Lob, there are the large steppe lakes Babakul and Bosta, at the foot of the Thian-shan. Of the desert Gobi more will be said under the next head, and Kan-fu, although cultivated in many parts, partakes on the whole of the desolate character of the other highlands and plateaux in this region. The climate of Chinese Turkistan is exceedingly dry, rains being rare phenomena, whence all cultivated fields are watered by artificial irrigation. The winters are very severe. The original inhabitants of the extensive tracts watered by the Ta-rim were Tadjiks, a nation akin to the Persians, and who are also, but erroneously, called Bokharians, because they are very numerous in Bokhara. The Tadjiks were conquered by the Turkish tribe of the Usbeks, who established several small principalities, gave their name to the country (Turkistan), and ruled over it till they were subjugated by the Chinese in 1757. Thence the European name of Chinese Turkistan. The Chinese themselves call it Thian-shan-nan-lu (the province along the southern foot of the Celestial Mountains), and it is a portion of their "Si-yu," or "West Country." There are also many Mongolish tribes in the country.

Third terrace, or Mongolia.

The most elevated plateaux of Monglia, which are overtopped by some of the loftiest peaks in Asia, lie in the S., in the In-shan, on the borders of China, and the Thian-shan, on the borders of Chinese Turkistan. They slope gradually down towards the Altaï, and the desert of Gobi, which occupies the central parts of Mongolia. The level of the terrace, consequently, varies very much, but measurements have only been made in Songaria, along the Altaï, and along the great caravan road which leads from Peking to Kiakhta, on the frontiers of Siberia. On ascending the plateau from Peking, the traveller is almost suddenly transported from a southern clime to a cold, dreary table-land, resembling Siberia much more than China. The point where the road crosses the great Chinese wall, lies about 5100 feet above

Asia.

the sea, and marks the beginning of the desert of Gobi; the level of Zaghan-bal-ghassu, further N., is 4200 feet; near Zakil-dakhan begins a sandy desert dotted with salt lakes, which lies much below the plateaux to the S. and N. of this tract, and seems to be the dried-up bed of an inland sea. It extends as far as Durma, where the soil changes from sand to a hard salt clay, producing saline plants, and strewn over with large fragments of rock, mostly porphyry and jasper, while in other places the steppe is literally covered with chalcedonies and agates. This tract is about 2400 feet above the sea, and the dreariest of the whole Gobi. The level rises in the direction of the Bussu-tchilon, or Belt Mountain, a steep, high wall of syenite rock, extending E. and W., and standing on a basis 3480 feet high. On the northern side of that conspicuous ridge, the plateau rises again to 4600 feet, at Djirgalanta, whence it slopes down to 4000 feet, at Erga or Urga, a large town at the foot of the lofty, wood-clad Khan Ula, and the capital of the Khalkhas Mongols. Erga lies at the northern foot of the Guntui range, which marks the beginning of the Gobi, but not that of Mongolia, on the side of Siberia.

Desert of Gobi.

Gobi is a Mongolian name signifying a country without trees and water, the same as the Chinese Shamo, and no less appropriate than the well-known terms Sahara and Ahkaf. It extends 1600 geographical miles from S.W. to N.E., with a width varying between 250 and 500 geograpical miles, and occupies the central portions of both the second and third terrace of Central Asia. The Gobi is one of the most desolate tracts on the face of the globe. The utter absence of fresh water, the deceiving salt lakes glittering in the midst of inhospitable solitudes, the whirling clouds of dust and the myriads of gnats which pursue the weary traveller in the summer, combined with the intense cold, the icy blast of hurricanes, and the all-burying snow storms of the winters, are phenomena no less redoubtable than all the horrors of the Sahara. But the Gobi also has its oases of luxuriant pastures around most of its salt lakes and along the steppe rivers, where the wandering Mongols pitch their tents of felt, and rear large herds of cattle, sheep, camels, and horses. The part occupied by the Chinese province of Khan-fu seems to be the least desolate; it is watered by two considerable steppe rivers, the Thola and the Bulon-ghir, and contains many settled inhabitants as well as some towns of importance. Our scanty knowledge of southern Mongolia has lately received most valuable additions through the journal of Mr Puch.

Mongolia Felix.

From the Guntui Mountains, in the territory of the Khalkhas Mongols, the Khing-khan, a high range, runs E. towards Mantchuria, and another, under various names, towards the Altaï in the W. This extensive mountain system is composed of the Khangai, the Guntui, and the Tangnu chains, and forms a curve connected in the W. and E. with the curve of the great Altaï system; and between the two curves lies an immense longitudinal tract, divided by northern branches of the Guntui and Tangnu into three basins. In the eastern basin are the head waters of the Amur; in the central one, those of the Selenga, which, after having crossed lake Baikal, assumes the appellations of Angara and Upper Tunguska, under which name it joins the Yenissei, of which it is the principal affluent; the western basin, finally, is watered by the upper course of the Yenissei, which rises here. But, although this great tract contains the sources of three of the greatest rivers of Asia, its elevation, except towards Erga, is much lower than that of High Mongolia, and not much above that of Southern Siberia, towards which it slopes down very gradually. Kiakhta, the frontier town of Siberia, lies 2100 feet above the sea. The political frontiers of Russian and Chinese Asia have been fixed across the tract without any consideration of natural boundaries, so that the northern portion belongs to Siberia, and the southern to Mongolia. It is inhabited by various Mongolian tribes. This circumstance, together with the abundance of water, the luxuriant pastures, the wooded mountains, and the comparatively genial climate, have given this tract the title of *Mongolia Felix*, a name not inappropriate, considering the contrast it offers to the adjacent Gobi. Western Mongolia, also, which is watered by the great steppe river Djabagan, which flows into Lake Ike Aral, is, comparatively speaking, a good country.

Songaria.

The westernmost part of Mongolia, or the plateau of Songaria, lies between the Altaï and the Thian-shan, along the western slopes of a high chain connecting those great ranges in a direction from N. to S. In its highlands there are peaks covered with eternal snow, and in the N. lies the Bielukha, the highest peak of the Altaï, to which Mr Gebler, who visited the country in 1833, assigns an elevation of 11,723 feet. In Songaria are the sources of the Bukhtarma and Erisis, which are the main feeders of the great Siberian river Irtish. It contains several large salt lakes, as the Kizilbash, the Alakta-gol, the Issi-gol, and the Dsaisang; and it slopes rapidly down towards the great Balkash, the elevation of which is under 1800 feet. Songaria is a thriving Chinese province, with a motley commercial, agricultural, and nomadic population of Mongols, Turks, Tadjiks, and Chinese, most of the latter being exiled or transported criminals.

Western Asia.

Western Asia contains Turan or Turkistan in the N.; Iran or Persia, Afghanistan, and Beluchistan, in the E. and S.; the Caucasus, the Armenian table-land, and Asia Minor, in the W.; and Arabia with Syria in the extreme W. and S.W. Its natural limits are,—in the N., none, although the low western spars of the Altaï are sometimes called so; in the E., the link between the Altaï and the Thian-shan (true Altaï of Humboldt), and the Bolor Dagh towards Mongolia and Chinese Turkistan, and the Indus towards India. The western and southern limits coincide with those of Asia. Western Asia extends 3000 geographical miles from S.W. (Babelmandeb), to N.E. (Altaï), and 2100 geographical miles from W. (Dardanelles), to E. (Bolor Dagh).

Turan or Turkistan

Turan or Turkistan comprehends the original seats of the Turkish race, that is, the Osmanlis, the Turkomans, the so-called Tartars (or, better, Tātărs) in European and Asiatic Russia, the Khirgises, the Usbeks, the Kara Kalpaks, the Bashkirs, and many other tribes, many of which have left their original homes to settle in distant countries.

Steppe of the Khirgises.

This vast tract measures 1300 geographical miles from W. to E., and about 500 from N. to S. It is partly a salt steppe, partly a grass steppe, the latter characteristic prevailing on the side of Siberia, into which it gradually merges. Low offshoots of the Altaï fill its northern parts. It contains a great number of salt lakes and steppe rivers. Among the former, the Balkash, on the borders of Songaria, has an area of 4800 square geographical miles, and is one of the largest in Asia; the Alaktu-gol, the northern Tenghiz, and the Tchurch-edshin, are considerable. The Ishim and Tobol Rivers, and other affluents of the Irtish, water the north; the steppe rivers Karaturgai, Naru, and Sarisin, the centre; and the Tchui, which issues from Lake Issi-gol, and empties itself into Lake Kaban Kulak, after a course of 700 miles, separates the steppe of the Khirgises from the slopes of the northern Bolor Dagh. Of the Caspian and the Aral, more will be said under the head "Turkistan." The Khirgises, a Turkish tribe, call themselves Kazaks or Cossacks, and are divided into three Hordes (a corruption of "ordu," tribe); namely, the Great Horde in the E., under the nominal supremacy of China and the Khan of Khokan, and the Little and Middle Hordes over which Russia has obtained a protectorate, which is more and more assuming the character of sovereignty. The fortified line of the River Ural is still the principal boundary of the Russian empire towards the

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steppe of the Khirgises, but forts garrisoned by Russian Cossacks have of late been erected along the lower course of the Sihûn, and the materials of three schooners having been conveyed on waggons from Orenberg to Lake Aral in 1847–48, that inland sea is now navigated by Russian vessels manned by Russian sailors.

Turkistan Proper.

The surface of Turkistan Proper shows a greater difference of level than any other known country, the highest peaks of the Bolor and Hindu Koh, together with the table-lands over which they rise, vying with those of the Andes and Himalaya; while the level of the Caspian lies 83. 67. below that of the Black Sea, and a large tract around it is also below the level of the ocean. The area of the Caspian contains 118,000 square geographical miles, and is as large as that of the Baltic. Lake Aral was carefully surveyed in 1847–48 by a Russian naval expedition under Captain Butakow, assisted by Captain Maksheyef, but the astronomical observations were made by Mr Lemm in 1846. The lake extends between the parallels of 43. 42. 41., and 46. 44. 42. N. Lat., and 58. 18. 47. and 61. 46. 44. E. Long.

The Aral, a large gulf called the Little Aral included, covers an area of 17,600 square geographical miles, or only one-half of that which it was until lately believed to have. It contains many islands, but only a few good harbours, and receives no rivers besides the Sihûn and the Djihûn; the supposition that the Djan Daria reaches the lake having not yet been substantiated. Its water is salt, though less so than that of the ocean, and near the mouths of the rivers so little brackish, as to be drinkable; its average depth is between 10 and 15 fathoms, its greatest, 37 fathoms; it is exposed to sudden and violent squalls, and abounds with fish, but there are no seals, of which there are such great numbers in the Caspian. Connected with the Aral in the S.W., is the large swamp Aibuyir or Laudan, which extends S. as far as 42. 30.[1]

The plains of Turkistan rise very gently towards the Bolor and Hindu Koh, the whole western slopes of which are a high, Alpine country, well wooded, and abundantly watered by the feeders and affluents of the Djihûn and Sihûn. The sources of the Sihûn, or Sir Daria, lie near the culminating point of the Bolor and Thian-shan, on the high table-land inhabited by the Karakalpaks, or Black Caps, a tribe of Turkish nomads who call themselves Buruts, and differ very little from the Khirgises. After a course of 1200 geographical miles, or perhaps less, and changing from W. to N., and again W., the Sihûn flows into the Aral through several channels, none of which is deeper than three feet. The Djihûn comes from the high plateau of Pamir (16,800 feet), where its sources were discovered by Lieutenant Wood; its course lies W. and N.W., and it forms a large delta at its mouth. Its total length is about 1400 geographical miles. The deepest of its embouchures has about 3 feet water. There can be little doubt that the Djihûn, the ancient Oxus, once emptied itself into the Caspian, a fact which was known by Jenkinson in 1558; Abulghazi, Sultan of Khozwarem, mentions it in his *History;* and a Russian survey all but confirmed it about thirty years ago. The ancient bed is still distinguishable, and in many parts filled with water. The climate of Turkistan, which lies between the isotherms of the rainless regions, is exceedingly dry, whence all cultivation ceases where there is no running water, or such as is obtained from the numerous canals of irrigation. But wherever fresh water is found, the land is well cultivated, and yields an abundance of grain and fruit of most excellent quality: the grapes, melons, peaches, oranges, and other exquisite fruits are renowned in Asia. The waterless districts are either salt steppes or sandy deserts, especially near the Caspian, and between the Aral and its two tributaries. A great proportion of the settled population of Turkistan are Tadjiks.

The country contains the independent Khanats of Khiwa, Bokhara, Kunduz, and Khokand; the two latter of which occupy nearly the whole tract of the western slopes of the Bolor Mountains, the high plateaux of the centre along the whole of the range being inhabited by tribes of Karakalpaks and other Khirgises, who are but little dependent on the neighbouring princes.

Iran, or Persia, with Afghanistan and Beluchistan.

A western continuation of the Hindu Koh, the range of Khorassan, and the Damani Koh, separates Iran from Turan, and decreases in height as it approaches the south-eastern corner of the Caspian. There the lofty chain of the Albors or Elburz rises suddenly, and trending W., connects the system of the Himalaya with the Caucasus and the Taurus. The highest peak of the Hindu Koh, in this part, is the Kohi Baba, N.E. of Kabûl, which rises 16,900 feet above the sea; in the Elburz, the volcanic peak of Demawend is 13,870 feet high. The northern part of Afghanistan is very mountainous; and the table-land of Kabûl is about 6000 feet high. To the W. of it, there is a great salt desert, in the midst of which are the fertile oases of Herat and Kandahar. On the plateau of Afghanistan are the sources of the steppe rivers Murghab, which flows N. into the plain of Turkistan; Heri Rud, which waters Herat and Meshed; and Hilmend, the most considerable of the three, which empties itself into Lake Hamun, on the borders of Persia. Beluchistan is a plateau, the interior of which is but imperfectly known. The slope of the plateau of Afghanistan towards the plain of the Indus is very abrupt, the mountain chains having in many localities the aspect of steep rock walls. Persia is a plateau from 3500 to 4000 feet above the sea, and nearly on all sides encompassed by lofty and rugged chains, through which narrow mountain passes lead into the interior. But it is open towards Western Turkistan and Central Afghanistan. Between Abushehr (Bushire) on the Persian Gulf, and Shirauz, there are no less than seven terraces. A large portion of the interior of Persia is occupied by a great salt desert, diversified in some places by highly fertile oases. On the whole, the interior of Persia is a miserable country, resembling the central parts of Arabia, and lying like them within the isotherms of the rainless region. But Mazanderan, the narrow district between the Elburz and Caspian, has a moist climate, in which trees and plants of every description grow most luxuriantly. In the west, also, the slopes of the Kurdistan Alps, and the Pushli Koh towards the Tigris, and the extremity of the Persian Gulf in Khuzistan, are well watered and highly productive. The latter chain is a portion of Mons Zagros of the ancients. The peak of Rowandiz, to the S. of Lake Urumiyeh is of enormous height. But the highest portion of Persia is the province of Azerbijan, which, however, belongs to the plateau of Armenia. See Persia.

The Armenian plateau.

The Armenian plateau occupies a large tract between the Anti-Taurus and the Caspian, and the plains of Mesopotamia and the Caucasus. It is of great elevation; the plain of Erzrûm being 6114 feet above the sea, which is about the average height of the whole plateau. Above this basis, a great number of peaks are covered with eternal snow, among which the Ararat is the highest (17,266 feet) The climate is very dry, but much less so than that of Iran and Turan; and there being an abundance of running water, cultivation is carried on with success on plains which otherwise would be barren. Deep valleys encompassed by steep rocks furrow the table-land in every direction; there the settled population accumulates, the nomadic tribes, chiefly Kurds, preferring the uplands. On the Armenian

[1] Ritter's Review of Maksheyef's description of Lake Aral, in *Monthly Bulletin of the Geographical Society in Berlin,* May 1852.

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plateau are the sources of the Tigris and the Euphrates, which flow into the Persian Gulf through a common channel; the Aras or Araxes, and the Kurtwa tributaries of the Caspian; and the Tchoruk and the Kizil Irmak, which empty themselves into the Black Sea. Among the lakes, two belong to the largest in Asia, namely, Urumiyeh (about 300 miles in circumference) or Azerbijan, and Lake Van (about 190 miles in circumference) on the Turkish territory. Mr Layard supposes the latter to be the real source of the Tigris, issuing from it through a subterranean channel. From the table-land of Armenia, the Elburz branches off E. towards the far Hindu Koh; the Kurdistan Alps branch off S.; and the Taurus and Anti-Taurus W. In the extreme N., along the Black Sea, an intricate system of irregular chains connects it with the mountains in the N. of Asia Minor, and, in an opposite direction, with the Caucasus, from which the plain of the Kur separates it further E.

The lofty chain of the Caucasus, which divides Asia from Europe, extends 600 geographical miles, between the Black Sea and the Caspian, in a direction from N.W. to S.E. The average height of its crest is 8000 feet; but upwards of a hundred peaks rise to a considerable elevation above it: the highest are the E. and W. summits of Elburz, respectively 18,513 and 18,449 feet, and Karbek 16,844 feet. The Caucasus is celebrated for the sublime wildness of its scenery. Among its wooded mountains rise the Kuban, the Kuma, and the Terek, in the N., the former joining the Black Sea, and the two latter the Caspian; and several of the head waters of the Kur, which flows into the Caspian in the S. It shelters hardy tribes of mountaineers, who have long maintained their independence. See CAUCASUS.

Syria and Arabia.

Syria is a link between Asia Minor and Arabia, its lofty mountains being connected in the N. with the Taurus, and in the S. with Mount Sinai, and the coast range of Northern Hedjaz. The principal southern portion of the Syrian mountains is the Libanon, which the valley of the Orontes, the Cœle-Syria of the ancients, divides into Libanus and Anti-Libanus. The highest peak is the Djebel Sheikh, or Great Hermon, the southernmost buttress of the Anti-Libanus, which rises abruptly over the plateau of Northern Palestine, and attains an elevation of at least 13,500 feet, and very probably 14,000 feet. Its summit is covered with eternal snow, whence the Arabs call it also Djebel-el-Teldj, or Snow Peak. See SYRIA.

Arabia is a table-land, except in the extreme N., where it slopes down to a low sandy desert. The elevation of the central plateaux varies between 3000 and 5000 feet, but those in the S., in Hadhramaut, are 8000 feet above the sea. The whole N. and centre of Arabia are within the isotherms of the rainless regions, but the southern portions are refreshed by tropical rains; the volume of which is, however, far from being the same everywhere, much depending upon local causes. See ARABIA.

Northern Asia, or Siberia.

Siberia was originally the name of a Turko-Mongolian Khanat, comprehending a large tract between the Ural and the Ob, and extending south over a portion of the steppe of the Khirgises. It was one of the fragments of the huge empire of Zinghis Khan, and took its name from the capital Sibir, of which some remnants are still visible near Tobolsk. The Kossack Yermak conquered Sibir in 1581, for his master, Ivan IV., surnamed the Terrible, Czar of Muscovy; and the Russian dominion having gradually extended itself over the whole of North Asia, the name of Siberia became the general designation of that vast region, as being the most prominent among the several territorial divisions of that part of Asia. The S. of Siberia is a mountainous country occupied by the Altaï system, except a tract towards the steppe of the Khirgises. Its greater western portion between the Altaï, the Ural, the Polar Sea, and the River Lena, is an immense plain of but little elevation above the sea; but Eastern Siberia, between the Lena and the seas of Okhotsk and Kamtschatka, is a mountainous country, except along the shores of the Polar Sea. The name *Altaï* is now generally, but improperly, given to the whole of the great mountain system on the borders of Central and Eastern Asia; but originally it only designated its westernmost portion around the sources of the Irtish, Obi, and Yenissei. The highest peak of that Altaï is the Bielukha in Songaria, which is covered with eternal snow, and 11,700 feet high, according to Gebler, or 12,790 according to Tchihatchaf. In both the Turkish and Mongolian languages, Altaï Dagh or Tau means *Gold Mountain;* and the abundance of that precious metal fully justifies the name. The chain of Ergik Targak runs E. towards the Baikal, and as far as that lake the system is called Western Altaï. The Baikal has salt, or rather brackish water, covers an area of 10,000 geographical square miles, and is surrounded on all sides by spurs of the Altaï.

The chain, improperly called *Eastern Altaï*, is composed of several chains, which are known by the collective name of the Daurian Mountains. The principal chain, which stretches far E. between Siberia and Mantchuria, is distinguished by its rounded summits, whence the Russians call it Yablonoi-Khrebet, or Apple Mountains. It is also called Stannowoi-Khrebet, or Stony Mountains: its Mantchu name is Khing-khan-tagurik. In the centre of the Daurian Mountains are the rich gold mines of Nertchinsk, a town situated on the Shilka, or northern branch of the Amur. Further E. along the sea of Okhotsk, are the Aldanian Mountains, with Mount Kapitan, 3780 feet high; and the extreme N.E. of Asia is traversed in every direction by the mountains of the Tchuktches, through which the Anadir meanders towards the entrance of Behring's Strait. These chains, together with their numerous northern spurs, are covered with magnificent forests, which, in the Aldanian Mountains, in N. Lat. 60°, reach an elevation of 2100 feet. Both the western and eastern chains are rich in various metals, and the gold mines yield precedence only to those in California and Australia. The great peninsula of Kamtschatka is a volcanic country, traversed from N. to S. by a lofty range, the southern portion of which is distinguished by a countless number of extinct volcanoes, situated along its western slopes. The northernmost, in N. Lat. 54. 40., is the Shiwelutch, and the highest the Kliutchef, 14,790 Parisian feet high, as measured by Erman. In the interior, especially in the Baidar Hills, are plateaux 1800 feet above the sea and covered with lava. The southern tracts of Siberia, those which belong to *Mongolia Felix*, as well as the valleys of the Altaï, and the plains along its northern foot, are a fertile country; and although the winters are very severe, the summers are hot, and the soil yields abundant crops. But the steppes in the centre, and still more those in the north, have a very different character.

The Ural extends from the shores of the Arctic Ocean, in N. Lat. 70°, to the middle course of the river Ural in N. Lat. 51°. The mountains in the island of Nova Zembla (among which Mount Glassowsky attains an elevation of about 2500 feet), are a northern continuation of the Ural; with which, in the extreme south, are connected the plateau of Uptchei Syrt, between the Volga and the Don; the low ridge of Mugodjar, which terminates in the steep plateau of Usturt, between the Caspian and the Aral, and other low hills in the steppe of the Khirgises. The main and central portion of the Ural consists of a principal western chain, from which many spurs branch off towards Russia; and two parallel chains on the Asiatic side, the easternmost and lowest of which is the Irmel, which rises abruptly over the steppes of Siberia. The highest summits are a little to the E. of, and detached from, the main chain, near Bogoslowsk, in Lat. 60°; they attain an elevation of from 8000 to 9000 feet, and

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among them the Daneshken Kamen is considered to be the highest. The highest summits in the S. are the Yurma, the Toganai, and the Iremel, none of which rises more than 4000 feet above the sea. The Pawdinski Kamen was formerly believed to be the highest mountain in the Ural, but its recent measurements have shown that it is not higher than the Taganai, viz., 3500 feet. Generally speaking, however, the average height of the crest of the whole Ural is not considerable. Near Katherinenburg, where the grand road from Europe to Asia leads over it, it is only 1600 feet; the highest point of the road between Miyask and Slatousk is not above 1800 feet; and the town of Katherinenburg lies only 900 feet above the sea. The northernmost portion is called the Obdor Ural; south of it the Poyos, the Werschourian, the Katherinenburg, and the Bashuirian-Ural. The Ural is rich in minerals, especially in the district around Katherinenburg, and its gold and platinum mines are the richest in the Old World.

Level of Siberia.

It has already been observed, that the basin of *Mongolia Felix* is a plateau much less elevated than High Mongolia, and that it slopes gradually down towards the low steppes of Siberia, a fact which could not escape the notice of those who had an opportunity of observing the gentle current of the great Siberian rivers. Kiakhta, on the steppe of the Selinga, on the frontiers of China, lies 2100 Parisian feet above the Polar Sea; the elevation of Lake Baikal, into which the Selinga flows, is 900 feet lower, or 1200 feet; that of the Irtish, near Tobolsk, about 500 miles from the Obi Gulf, is 110 feet; that of the Obi at Barnaul, in the midst of the northern spurs of the Altaï, is only 360 feet. But Siberia, around and east of the Baikal is more elevated, and the low steppes begin in a much higher latitude. They increase in desolation towards the N., and between the 70th parallel and the Arctic Ocean they present the aspect of an immense frozen swamp, the surface of which, thawing up in the summer, covers itself with moss. These dreary plains or Tundra, were first and graphically described by the Russian Admiral Wrangell.

Southern Asia.

This division comprehends Hindustan, Burmah, Siam, Laos, and Cambodia, and though not in extent the largest, it is in many respects the most important portion of Asia.

Hindustan.

It is not easy to give the extent of Hindustan with precision, from the extension given to the appellation by geographers; but if we carry a straight line from Cape Comorin, its southern point, to the northern boundary of Cashmere, its extreme length may be stated at 27° of latitude, or about 1890 English miles. Its form is an irregular triangle, the greatest breadth of which, in Lat. 24° N. from the mouth of the Indus, to the mountains of Cassay in Burmah, extends from Long. 69° to 92° E., a distance of about 1250 English miles. This area has an exceedingly varied surface, and contains a very mingled population. The northern and western portions are diversified by mountain ranges, often exceedingly steep and rugged; especially in the northern provinces, where they may be considered as spurs of the vast Himalaya chain; and also in the less lofty range which skirts the western coasts of the Indian peninsula, distinguished by the name of Western Ghauts, which in some points attain an elevation of from 4000 to 5000 feet. The mountains of the eastern side are far less elevated. A great portion presents extensive valleys, or vast plains, watered by noble rivers; but in a few places there are wide deserts, as on the eastern side of the Indus; and where water is deficient, as on portions of the eastern coast, there are sandy wastes. But in the plains traversed by the Ganges and its numerous affluents, by the Bramahputra, the Ganga, the Nerbudda, and the Kristna, the soil is of surprising fertility, and often presents scenes of varied beauty. Where nature has denied the usual means of irrigation, art has often supplied the deficiency by artificial canals, and an enormous population finds the means of subsistence. These riches are not without alloy. Wherever water stagnates, especially in the midst of thick jungle, that locality becomes the chosen abodes of malignant fever and of spasmodic cholera; scourges that annually carry off multitudes in every part of India. The mountain streams for ages have afforded golden sands; eclipsed however in latter times by the riches of the Ourals, of California, and Australia. The central part of Hindustan affords diamonds; and for ages the only locality of that gem was believed to be Golconda.

The population of Hindustan consists of various races. The original inhabitants are said to be still represented by some mountain tribes, that may be yet distinguished from the Hindus, the Malayans, and the Cingalese; and the less swarthy Mahometan population are descendants of Arabian, Persian, and Tartar immigrations. See HINDUSTAN.

Burmah.

The country now known under the name of Burmah comprehends the kingdoms of Ava and Pegu. Its northern boundary is the mountains of Assam; its western, British India and the Gulf of Bengal; the southern, the Malayan peninsula; and the eastern is Siam. Its extent is not well defined; but it appears to stretch from the 9th to 26th degree of N. Lat., or a length of about 1080 English miles, with a varying breadth from 600 to 240 English miles. The northern portions are mountainous, and afford gold, silver, sapphires and rubies; but the principal part is a vast plain, watered by the noble Irawaddy and its affluents. The lower portions, about Rangoon and Pegu, are low and swampy. The whole is the seat of a warlike people, that have twice braved the armies of British India with more than Eastern courage. See BURMAH and AVA.

Malaya.

Malaya or Malacca is a narrow peninsula extending into the Indian Ocean, with a length of about 700 English miles, and a mean breadth of 150; and it has numerous fine harbours. On the coasts are some European settlements, one of which, Singapore, belongs to Great Britain. The interior is a longitudinal mountain chain, from which various arms descend on either hand. The interior is imperfectly known to Europeans. The native Malays are an enterprizing, restless, vindictive race, much given to navigation and to piracy. In former times, they appear to have spread themselves over a considerable portion of the Pacific. See MALACCA.

Siam, Laos, Cambodia.

Of the interior of Siam, Laos, and Cambodia, we know little. They occupy two extensive river-valleys between Burmah and the mountains that join the western boundary of Cochin-China. Both rivers are navigable for a considerable distance, especially that of Siam, which bears the name of Maygue, and appears to arise in the mountains of Tibet, and falls into the Gulf of Siam. The river district, including Cambodia and Laos, is divided from Siam by a wide group of mountains running N. and S. It owes its fertility to the Maykung, a large river, also arising in Tibet, and running parallel to the Maygue. Both rivers are subject to periodic inundations, that give great fertility to the regions through which they pass. Laos is represented by Kæmpfer as a powerful state, protected from foreign enemies by deep forests and rugged mountains. It lies N. of Cambodia, with which it is conterminous. The valleys are fertile; the mountains produce gold and sapphires. Cambodia is chiefly known as producing the drug we term *gamboge*, which is probably the juice of a *Hebradendron*.

Eastern Asia.

Eastern Asia comprehends Cochin-China, Tunkin, and the Chinese empire.

Cochin, Tunkin.

Cochin-China or *Southern China* is a narrow mountainous tract, bounded on the E. by the ocean, on the W. by deserts and mountains, that separate it from Cambodia and Laos, and on the N. is divided by a small river from Tunkin, which it has lately partially conquered. It has many good harbours along its extensive coasts, of which Turon is

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the best known. Staunton represents the country as fertile and well cultivated, the people as industrious and civilized. They, as well as the Tunkinese, are of Chinese descent. Their coasts abound with the edible birds' nests, formed by a species of swallow. See COCHIN-CHINA and TUNKIN.

China. The vast empire of China presents an area computed at 1,297,999 square miles, according to Staunton, and a population of 333,000,000, being the most densely peopled region of the earth. Its enormous surface is much varied, producing the vegetable riches of every climate. Chinese Tartary is very mountainous; and chains of granite mountains traverse China in various directions; but the great chains generally run from W. to E., and send the principal rivers in that direction through fertile plains of enormous extent. The principal of these rivers are the Amur, in the north; the Hoan-ho, and Kian-ku in the central districts, both having a course of more than 2000 miles; and the Hon-kiang, and Pe-kian in the S. It is needless to state here what is discussed fully under CHINA.

Oceanic Asia. Oceanic Asia embraces all the Asiatic Isles properly so called; and some would also include under this head the distant New Zealand, and vast continent of Australia. We limit this division to Ceylon, the Andaman Isles, the Sumatran chain, including Java, &c., Borneo, Celebes, the Moluccas or Spice Islands, the Manillas or Philippines, Formosa, Lu-ku, Japan, Jesso, and Tchoma. For a particular account of this division, we refer to the different heads just enumerated.

Climate. Asia, extending from the equator to the Arctic Sea, necessarily possesses great variety of climate. But though here, as in every other country, the climate is regulated by the distance from the equator, this general law is modified by accidental causes, which it is curious to trace. In the wide extent of Asia great peculiarities of temperature occur, which cannot be very clearly explained. To such inquiries some uncertainty will always attach, and anomalies may appear of which we can offer no solution. Facts are our only sure guides; and to these, therefore, in the following observations, we shall endeavour to adhere.

The height of the land above the level of the sea is as sure a cause of cold as distance from the equator; and countries are not only cold in proportion to their height, but a mass of cold air is accumulated above them, which, being dispersed, is carried towards the equator, and extends the dominion of cold into the regions of heat. Land and water, also, are the causes either of heat or cold, according to their situation. The great mass of the ocean is little affected by the changes of the seasons; and it consequently preserves the medium temperature of the whole year. Hence the vicinity of the ocean cools the temperature of the equinoctial regions; and in higher latitudes it moderates the extremes both of heat and cold, being in winter of a higher temperature, and in summer of a lower temperature, than the superincumbent air. The surface of the earth, again, imbibes heat or cold much more readily than the ocean; and it is only at considerable depths that it is found to give the medium temperature of the year. The vicinity of land, therefore, in the polar countries, is the cause of cold, while in the southern regions of the equator it is an equally powerful cause of heat. Thus Africa, which extends so far to the S., and which contains a greater proportion of land within the tropics than any other division of the globe, is a vast store-house of heat, from which it is dispersed far and wide, and even reaches the shores of Europe in hot and parching winds; while, on the other hand, the breadth and extent of the American continent towards the N. sufficiently accounts for the coldness of its climate—the N.W. winds which sweep across its frozen wastes extending their inroads into the regions of heat as far sometimes as Mexico or Vera Cruz.[1] The influence of the ocean in moderating the severity of the winter is exemplified in the climate of Great Britain, where no such intense cold ever prevails as in corresponding latitudes on the continent of Europe, and more especially on that of Asia. The climate of a country is also affected by the direction of the winds; and hence the eastern shores of America, owing to the trade-winds, which blow from the E., and are cooled in their passage across the Atlantic, have not the same sultry heats as the opposite shores of Africa, where the same winds are heated to an intense degree in their passage over the burning deserts of the interior. The northern frontiers of Asia, and its prodigious elevation towards the centre, necessarily consign the greatest portion of it to the dominion of cold. Among the central mountains perpetual winter reigns; and from these snowy deserts the influence of cold is widely extended over the high plains of the interior. In Tibet, which is about the same latitude as Northern Africa or Arabia, namely, between the 30th and 35th degrees, there is a continuous and severe winter of three months, which is of such uniform severity that at its commencement the inhabitants kill their meat, and it is kept perfectly fresh for three months.[2] To the W., along the whole range of elevated country that extends into Persia and to the Caspian Sea, the climate is modified by the elevation of the ground. In the countries of Balk and Bokhara, which lie on the northern declivity of the great ridge of the Hindu Koh Mountains, in the same latitude as the S. of Europe, namely, the 39th and 40th degrees, and all along the banks of the Oxus, the climate is remarkably severe. For three months the winter is intensely cold, the wind being dry and piercing, and the snow lying deep on the ground. The rivers are all frozen over, and the Oxus during all that period is passable for caravans.[3] The summer, again, is equally hot. Persia, in like manner, being nearly in the same latitude as Arabia, the hottest part of the earth, and having an excessively hot summer, has in the northern and central parts the severe winter of a northern climate, with drifting snow, which lies deep on the ground for three months; and this is owing entirely to its elevation, which is estimated by Fraser to be 4000 feet above the Caspian Sea.[4] The lower valleys and exterior plains of Asia, which lie to the south of the Himalaya Mountains, including Arabia, the southern and flat parts of Persia, Hindustan, and India beyond the Ganges, constitute the tropical and warm regions of this continent, of which the climate, though it agrees in general with their position on the globe, still varies from local causes. Hindustan, for example, and India beyond the Ganges, though they approach nearer to the equator, are not nearly so hot as Arabia or the adjacent countries. The course of the seasons is also more constant; and it is here that we meet with those remarkable winds, the monsoons, which blow six months in opposite directions, from the S.W. and N.E., with some slight variations, and which extend their influence over all the countries

[1] See Humboldt's *Political Essay on the Kingdom of New Spain*. He mentions that at Vera Cruz the centigrade thermometer sometimes falls, owing to those northern blasts, to 0 or to 32 degrees of Fahrenheit; and that even at Mexico they sometimes, though rarely, bring down the thermometer to the freezing point.

[2] Turner's *Embassy to Thibet*, p. 217, 301, 356.

[3] Fraser's *Narrative of a Journey into Khorassan*, Appendix, p. 95.

[4] Kinneir's *Geographical Memoir of the Persian Empire*, p. 122. It is mentioned in the Journal of a Mr Campbell, quoted by Sir J. Malcolm, that while he was at Tabreez a heavy fall of snow occurred in May; and in December and January the thermometer at night was never above zero. (Sir J. Malcolm's *History of Persia*, vol. ii. p. 509.)

which lie between the mouth of the Indus and the Chinese Sea. The monsoons follow the course of the sun, and this fact points to the cause of the phenomenon. Heat and cold being the great agents which, by rarefying or condensing the air, disturb its equilibrium, and set the winds in motion, land, when it is heated by the solar rays, acts on the superincumbent air, and causes it to ascend, when it is immediately replaced by an irruption of cold air from the sea. Hence the regular sea-breeze which prevails in all the tropical islands during the day, and the opposite current from the land during the night; and this alternation of the sea and the land breezes, occasioned within 24 hours by the varying temperature of an island, is just an example of the effect that must be produced by a heated continent and by the change of the seasons. As the sun advances into the northern tropic, the land of Asia, Europe, and almost the whole of Africa, is heated by his influence; by which the air being rarefied, and rising aloft, a current of colder air rushes in from the sea. Accordingly it is found, that with the approach of summer, the plains of Hindustan, Burmah, and China, heated by the intense rays of a vertical sun, powerfully attract the cold air, which flows with a steady stream from the Southern Ocean, exactly in the tract of the heated continent, namely, from the S.W. to the N.E. When the sun passes into the southern hemisphere, the monsoon alters its course. Winter now reigns in the mountainous and northern parts of Asia, and the heat in the lower regions is not so great. The land, in place of heating, cools the air, which flows into the warm regions of the S. from the N.E. in the direction of the continent, as it formerly flowed towards the N. from the S.E. The S.W. monsoon sets in about the beginning of June in all the islands of the Indian Ocean, and traverses the southern plains, until it is turned towards the W. by the central mountains, and finally arrested in its progress. It is ushered in with the most tremendous thunder and lightning, with tempests of wind and floods of rain. This is the commencement of the periodical rains through all the tropical regions of Asia, which are at their height in July, and gradually abate about the end of September, departing amid thunders and tempests, as they came. Before the setting in of the monsoons there is a clear sky, with a hot parching wind, succeeded by sultry calms, under which all nature seems to droop. The rains effect a sudden and total change in the aspect of the country: the rivers are swollen, the air is pure and refreshing, the sky varied with clouds, and the earth covered with the most luxuriant verdure.[1] Such is the climate of Southern Asia, from China to the southern coast of Africa. But the peninsula of Arabia is not subject to the influence of the monsoons; and in place of the tropical rains, it has generally, in the mountainous parts, the winter and the spring rains.[2] The climate during summer is hotter than in any other part of the world, the thermometer frequently rising to 110°, and even, it is said, to 120°, in the coolest and shadiest parts, while dead calms prevail often without interruption for 50 or 60 days, and are succeeded, as the temperature begins to vary and the winds to resume their activity, by violent and hot blasts from the desert. The vicinity of Arabia to the African continent, by which it is sheltered from the cool breezes of the sea, while it receives the sultry air from its burning plains, is unquestionably the cause of its extraordinary heat; and it will be remarked that those violent heats extend eastward from Arabia exactly in the direction in which they are received into the lower valley of the Euphrates and the Tigris, where at Baghdad they raise the thermometer to 120° in the shade. It has been already mentioned that the progress of the monsoons to the N. is arrested by the central mountains; and the elevated tract of country, therefore, which lies to the N. of this barrier, namely, the kingdom of Kokaun, over which are spread the headwaters of the Oxus, Balk, the ancient Bactriana, Bokhara, and the countries W. of the Indus, as far as the Hellespont, depend on the spring and the winter rains which they receive from the W.[3]

Western Asia has been long celebrated for the mildness and serenity of its climate, which is hot and dry, though it is tempered by the cool breezes from the mountain tracts by which it is intersected. In the northern parts, along the coasts of the Black Sea, the country is liable to excessive rains; while the southern shores of the Mediterranean are exposed to the sultry simoom blasts from the African or Arabian deserts.

Northern Asia, of which the Altaï chain is the boundary, is the proper region of cold; and the severity of the climate is said to be aggravated by the vast expanse of the continent in the frozen latitudes of the N. In the interior of Asia the milder element of the ocean can have no influence on the rigour of perpetual winter; and from the Arctic Ocean to the Altaï Mountains the north wind sweeps without interruption along the Siberian plains, and occasions an intensity of cold which is not experienced in the corresponding latitudes of Europe. It is remarked by Malte-Brun, that the cold increases as we proceed eastward, to such a degree, that on the coasts of Mantchuria, in the same latitude as France, the winter commences in September. This intensity of cold he ascribes to several causes: *1st,* To vast mountains covered with glaciers, which rise between Corea and the countries on the river Amur; *2dly,* to the still greater mass of mountains which separates the Amur from the Lena; *3dly,* to the thick and cold fogs which constantly overhang those frozen countries, and intercept the rays of the sun; and, *4thly,* to the absolute want of inhabitants, and consequently of cultivation. This, however, is only true with regard to the extreme N.E. of Asia; but in the whole, such causes tend to the increase of cold. They are, however, counterbalanced by the influence of the Eastern and Arctic Oceans; and the average cold is consequently greater towards the centre of the continent than along its northern shores. The average cold of the winter in Nova Zembla, between N. Lat. 70. 30. and 73. 30., is −35° 30′ Celsius; its minimum was −39° 30′; but at Statust, in N. Lat. 55., near the Ural, it is as low as 44°, while the minimum was 46.° The greatest cold ever observed in Asia was at Nishneï Kolymsk on the Kolyma, in N. Lat. 68. 32., namely −50° 20′ on the 8th January 1821.

Vegetable productions.

Asia, from its vast extent and unequal surface, not only comprehends within its bounds the vegetable produce of the whole earth, from the low creeping lichen which flourishes on the borders of perpetual snow, to all the splendid varieties of tropical vegetation; but it presents these varieties within a very short compass. It would be inconsistent with the plan of the present article to describe in detail the animal and vegetable kingdoms of Asia. It may be therefore generally stated, that the great staples of agriculture, the alimentary plants on which man depends for his subsistence, are, in the tropical countries of Asia, rice, of which there are 27 varieties; maize, millet, and many varieties of a coarser grain called dourra; as well as other species of legumes not known in Europe. The cultivation of these nutritious grains is confined to the plains of Hindustan and the hot countries to the east. Rice or maize may be sometimes seen in Persia, or in the hot plains of Lower Syria; but agriculture in these countries generally depends on the

[1] Elphinstone's *Account of Cabul,* chap. v.

[2] Niebuhr, vol. ii. sect. 29.

[3] Fraser's *Narrative of a Journey into Khorassan,* Appendix, p. 95.

grain of a colder climate. Persia is accordingly famed for the most excellent wheat, which is the chief food, and for barley and millet. Oats are more rarely attempted in that climate. Throughout Syria and Asia Minor, as well as Arabia, wheat, rye, barley, beans, and other grains, are chiefly sown; and in Bokhara, and generally in all the countries that lie between the Oxus and the Caspian Sea, these and other grains, with a variety of leguminous plants, constitute the chief aliment of the inhabitants.[1] Between the 50th and 55th degrees, these grains may with care be raised all over Asia; but beyond this they cannot so well resist the severity of the climate. This is therefore the proper region of barley and oats, the cultivation of which may be extended to the 60th degree. Beyond this the powers of vegetation begin to fail; and the forests present dwarf trees with lichens, and some species of eatable wild berries, among which is the *Empetrum nigrum*. In ascending the Asiatic wild mountains, the same varieties of vegetable produce are observed as in receding from the equator, until, at the line of perpetual congelation, all traces of vegetation disappear. But the decrease of heat in proportion to the altitude varies in different situations, according as it is affected by local and accidental causes; and though the most accurate calculations have been made on the subject by Leslie, Humboldt, and others, they are modified by local causes. Thus the limits of perpetual congelation have been fixed by Humboldt at 15,700 feet under the equator, and 15,000 in the latitude of 20 degrees; yet Captain Webb, in his journeys among the Himalaya Mountains, observed, on the banks of the Sutledj river, which must have been at least in the 30th degree of N. Lat., the finest pastures, and crops of a species of barley from which the natives make their bread, at a height of 15,000 feet, the supposed line of perpetual frost. And at a pass among these mountains, in 30 degrees of N. Lat., plants were found that ripened their seed at the enormous height of 17,000 feet. In Lat. 30. 25. the same travellers saw fields at the height of 11,790 feet, not only without snow, but covered with extensive crops of buckwheat and Tartaric barley. The decrease of heat in proportion to the altitude attained appears to be affected in those climates by the transport of the warm moist air of the S.W. monsoons from the Indian Ocean. We cannot fix either the lower or the higher limit at which wheat and other European grains could be brought to maturity among the Asiatic mountains. It is evident that the decrease of heat as we rise above the level of the sea is modified by local causes, in the same manner as when we recede from the equator; and hence the same vegetable produce is not uniformly found at the same height, any more than within the same latitudes. It is possible that in the interior mass of the mountains the cold may be greater than among the exterior ridges, and that the European grain, and the other congenial produce of a cold climate, may not on this account ripen at so high an elevation. It is mentioned by Turner, that he saw wheat in Tibet in a green state, which he was assured would never ripen owing to the severity of the climate.

Of the other plants which minister to the comfort of man, and afford valuable articles of commerce, Asia possesses great variety. The tea plant, which is exported so largely to Europe, is indigenous to China, to which it is a source of prodigious wealth. It has more lately been found also in Assam, where it has been successfully cultivated by the British. Arabia is the native country of coffee, where it still arrives at its greatest perfection. The sugar-cane is cultivated in Hindustan, though not with the same energy and skill as in the West Indies; and also in some of the hottest parts of Asia Minor. Tobacco is very generally produced in Southern and Western Asia; and opium, the great intoxicating drug of the East, is an important article of cultivation in Hindustan. It is chiefly produced in Bengal, Bahar, and Malwah; and upwards of 4,000,000 pounds of opium were annually sent to China, before it was prohibited by the Chinese government. The vine grows to great perfection among the rocky heights of Palestine, and in the mountains of Syria, where wine of a good quality is made, and also in Arabia and Persia. Industry and skill are alone necessary to improve the advantages of nature, and to render this precious produce a valuable article of commerce. The cotton shrub, which yields so useful an article of clothing, has from time immemorial been cultivated in India, growing in Arabia, Persia, and throughout Asia Minor; and the mulberry which, by feeding the silkworm, affords so splendid an article of dress, is grown with success in Syria, Mesopotamia, and Armenia. Flax and hemp are common throughout both Southern and Western Asia, and they would grow also in Northern Asia if the inhabitants knew how to profit by the advantages of the country. Indigo is another important article, which is cultivated in India and in some parts of Syria, as well as in Arabia. The Asiatic islands have been long celebrated for various aromatic plants; and the juice which exudes from the trunks of the smaller trees is of the richest fragrance. Among the species of laurels which abound in the southern parts of India and Ceylon we find those which produce mace, cassia, and camphor; and, lastly, the cinnamon tree, formerly supposed to be a native of Arabia; also the clove and the nutmeg trees. The balm of Mecca is the finest of all the tribe, and diffuses an exquisite perfume. Arabia has been long celebrated for frankincense and myrrh. Asia furnishes also many plants used in medicine, as well as in dyeing, such as the castor-oil plant, the senna, the aloe, and others, which extend all over the southern parts and through Asia Minor.

In Southern Asia the forests abound with the most valuable trees, with the most durable woods, and with every variety of ornamental and dye-woods. The teak tree, which grows in the woods of India, surpasses all others in durability. There are many trees which minister to the wants and appetites of man. The sago palm yields from its stem and roots the well-known farinaceous substance which bears its name. The toddy palm yields a rich juice which, when fermented, becomes a strong spirituous liquor. The fan palm, which grows in some parts of India, is remarkable for the breadth of its leaves, one of which is sufficient to cover a dozen of men, and two or three to roof a cottage. The bread-fruit tree, which grows in India, yields a farinaceous fruit resembling bread prepared from grain. All the common fruit trees of Europe are also found in the hilly parts of India. Asia Minor and the banks of the Euphrates abound in the myrtle, the laurel, the turpentine, mastic, tamarind, cypress, sycamore, and other trees. The oriental plants are numerous in Persia; and in the Syrian mountains the oak and the cedar, celebrated in ancient times, grow to a great height. In the northern countries of Asia the trees most prevalent are the oak, the ash, and the elm; and still farther N. there is the dwarf birch and the mountain willow; also the pines and the firs, which rear their tall heads, and spread over the scenery their permanent hue of dark green. The strong and glutinous liquid which exudes from these northern trees is converted into tar, pitch, and turpentine, and becomes a valuable article of commerce, useful for many purposes.

All the most delicious fruits are raised in the tropical countries of Asia. Those most celebrated in India are the guava, the jambo, the mango, and the pine-apple: many others might be raised if garden-cultivation were carried to

[1] Fraser's *Narrative of a Journey into Khorassan*, Appendix, p. 96.

Asia.

the same perfection as in Europe. Syria, Palestine, the banks of the Euphrates, and Persia, are famous for the variety of their fruits, and produce abundantly pomegranates, oranges, lemons, almonds, peaches, figs, quinces, olives, walnuts, and melons of all sorts. In the neighbourhood of Damascus all the fruits of Europe arrive at maturity; and near the Caspian Sea there are whole forests of chestnut trees. The date tree, the fruit of which is in many parts the chief subsistence of the inhabitants, grows in Persia, Mesopotamia, Arabia, Syria, and Palestine. In the higher parts of these countries other fruits are to be found, namely, the apple, the pear, the cherry. In Northern Asia, horticulture is little practised; and, excepting wild berries, few other fruits are to be seen in its desert and inhospitable plains. Flowers of all sorts, in the most splendid profusion and variety, and of the richest fragrance, adorn the country in Southern and Western Asia, and give it the appearance of a flower-garden. On such a subject, however, which presents so wide a field of inquiry, we cannot enter into details, which would hardly prove satisfactory to the general reader, and still less to the man of science.

Animals.

The desolate tracts of thick jungle and dense forest which abound in Asia afford extensive cover for wild animals, which are accordingly found in great numbers, and comprise all the known *genera* of the globe. The lion is found in Persia, Mesopotamia, on the banks of the Tigris and Euphrates, and was formerly known in Asia Minor, but has now either entirely disappeared, or is rarely seen. It was at one time supposed that this formidable animal did not haunt the forests and jungles of India. But lions have been seen in great numbers in the N. of India, in Guzerat, and in the province of Delhi, to the N. of that place.[1] The tiger is a native of Asia, to which continent he exclusively belongs, having never migrated into the other regions of the globe. He is spread over all parts of Southern Asia, from the islands of the Indian Ocean, where he exists in amazing power and ferocity, to the great ridge of the Himalaya Mountains.[2] His progress northward is checked by the increasing cold; yet is he found in some of the higher regions, where ice is seen during the winter. It is certain, however, that he is a native of a hot climate; and it is probable, therefore, that when he feels the approach of winter, he retires from the cold of the high country into the warmer and lower valleys of the south. Tigers are seldom seen in the countries westward of the Indus, though they may occasionally stray from their native haunts along the W. of that river into the mountain tracts of Beluchistan.[3] The tiger is not found in Persia, Arabia, or in any part of Africa, though it is quite certain that the country is quite congenial to his constitution and habits, and that if he could once reach it he would quickly propagate his race through its deep forests. Yet the lion reigns supreme in the woods of Africa, while the tiger is the lord of the Asiatic jungles. It would be curious, if we had full materials for such a speculation, to trace the distinct regions of the globe which are occupied by the various animal and vegetable tribes. Plants, we know, are transported from the countries in which they are indigenous, and flourish in another soil and climate equally congenial; and, in like manner, the animals of one country have been transported with equal success to other countries, where they have multiplied. The wild and ferocious animals it is the object of man to destroy rather than to increase; and they would therefore receive no aid from him in their migrations from one region to another. Hence we find that those countries which are widely separated, and which present no practicable communication for animals, have each its own peculiar and distinct class. America has an entirely different race of animals from Africa or Asia; while the animals that are found in the islands or continent of Australasia resemble those of no other quarter of the world. The zoology of Asia and Africa, from their vicinity, and from the comparatively easy communication between them, does not present such diversities; yet it is remarkable, that while the lion is common over all Africa, the tiger has never yet been seen; while in Asia it is nearly the reverse, the tiger, and not the lion, being the more common of the two. There can be no reason, we should imagine, why the tiger should be confined to Asia, while there are other countries equally suited to his habits, except that, being indigenous in the regions of Eastern Asia, he has never been able to cross the barrier of mountains and deserts by which these regions are separated from Persia on the west. Beyond the western banks of the Indus the country is mountainous and impassable, and the climate extremely cold; the ridges from the Himalaya Mountains extending southward nearly to the sea, and the country beyond being merely a narrow strip of hot and sandy desert. Beyond this, farther to the W., extensive deserts are found destitute of water and of all traces of vegetation, which would as effectually oppose the passage of wild beasts as the trackless ocean which divides Africa and America, and leaves to each its own class of indigenous animals. The other wild animals of Southern Asia are leopards, hyenas, jackals, tiger-cats, wild boars, antelopes, elks, red and other deer, foxes, hares, mangooses, ferrets, porcupines, &c. All these are to be found in the southern plains of Asia. The hyenas, wolves, jackals, and bears, abound in some of the hilly tracts, and in the mountains of Beluchistan and the other countries to the west of the Indus. The first three make dreadful havock among the flocks. The same animals are found in Persia, Mesopotamia, in Asia Minor, and in Palestine: and it is said that the lion is occasionally seen on the banks of the Jordan. The ounce is a formidable animal in these countries and in Syria, and is sometimes mistaken for the tiger. The striped hyena is often to be met in the Persian forests.[4] The wild dog is common in Northern India, in Beluchistan, and in all the mountainous countries to the E. of Persia. It is a large and powerful animal, and extremely ferocious. They hunt in packs of 20 or 30, and frequently seize a bullock, which they kill in a few minutes.[5] The bones and remains of tigers, supposed to have been destroyed by the combined attack of these animals, are also sometimes found in the woods of Northern India.[6] The wild ass is a native of Persia, and is remarkably wild, and fleet in its movements. It is also common in the northern mountains of India, and in the countries to the west of the Indus. The hemionus or wild horse is found about the Sea of Aral. The wild sheep and the wild goat are common among the mountains.

Of the domestic animals, the elephant claims the preeminence, being unequalled by any other animal for the purposes of draught. This animal is confined to the southern countries of India, where the climate is hot, being seldom seen in the mountainous tracts towards the N. The camel is used for domestic purposes over a far wider extent of country than the elephant. This animal is of two species, the one with two humps, and the common camel with only one hump. The latter is the camel of Arabia, Syria, Persia,

[1] Elphinstone's *Account of Cabul*, p. 141.

[2] Bishop Heber.

[3] See Pottinger's admirable account of the countries of Beluchistan and Sinde, chap. vii. which is replete with interesting information. The journey of this officer and of Captain Christie, from India to Persia, through these wild tracts, inhabited by hordes of robbers, may be considered a most perilous and honourable achievement.

[4] Kinneir, *Memoir of the Persian Empire*, p. 42.

[5] Pottinger's *History of Beluchistan*, chap. vii.

[6] Bishop Heber.

India, and Northern Africa. A lighter variety of this species is the dromedary, used only for riding, and differs from the camel of burden as the racer does from the draught-horse. The two-humped camel is the Bactrian species, and is so rare, even in Western Asia and India, that Captain Lynch states, that in a caravan of 5000 camels, there were not above eight or ten of this Bactrian species. In Mongolia, however, they are very numerous. The dromedary is chiefly used for travelling, and its valuable quality is swiftness, by which, joined to its capacity of enduring hardship, it is qualified to travel at an incredible rate for many successive days. In all the low countries, especially in the dry and sandy tracts, such as Arabia, Syria, &c., the common camel is employed. The two-humped camel is a native of the high countries in the neighbourhood of the Oxus and the Jaxartes, where it is still chiefly used. So large a portion of Asia is occupied by vast plains and wastes of sand, that its interior intercourse must be maintained by land journeys. But without the aid of the camel, it would be impossible to traverse extensive deserts destitute both of food and water; and in those arid countries such an animal, which has been truly called the *ship* of the desert, is the most valuable gift which Providence could bestow.

The other domestic animals of Southern and Western Asia are horses, mules, asses, buffaloes, black cattle, sheep, goats, &c. Arabia may be considered the native country of the horse, in which he arrives at the highest perfection, and combines all the most estimable qualities of symmetry form, fineness of skin, fire, docility of temper, fleetness, and hardiness. It is chiefly from the Arabian breed that the horses in other parts of the world have been improved. In Persia the horses are neither so graceful nor so swift as those of Arabia, being high, with long legs, spare carcases, and large heads; but they are highly prized by the inhabitants for their extraordinary capacity of enduring fatigue. To the E. of Persia, at Herat, the breed of horses is fine; also on the banks of the Indus and its tributaries; and in the higher regions of Balk and Bokhara they are excellent and numerous, and are exported in great numbers to Hindustan.[1] The mule and the ass, all over India, are miserable animals. The mules are of better quality in the Punjaub, on the upper course of the Indus, and they improve still more further west. In the countries W. of the Indus, they are superior to those in Hindustan, and in Persia there is a still finer breed. But the mule of the East is inferior to that of Europe. The ass partakes of a similar improvement in his progress westward, and is a far finer animal in Western Asia than in Europe. In Syria, Palestine, and generally in Asia Minor, he is distinguished by agility, fire, and patience of fatigue, and ranks in the first class of domestic animals. Buffaloes are found in the hot plains of Asia, as well as in the mountainous tracts; and the oxen which are used in the plough have all a hump on their backs. The wealth of the pastoral tribes, who rove about in the western plains of Khorassan, and in the hilly tracts of Afghanistan, consists chiefly in sheep, which have tails a foot broad, and composed entirely of fat, but in other respects resemble the English sheep, being better and handsomer than those of India.[2] Goats are common all over Asia, especially in the mountains, where there are some breeds with curiously-twisted horns; and they are by no means scarce in the plains.

In the northern parts of Asia, and in the high mountain tracts, a different class of animals is to be found. These cold regions are not distinguished by the same profusion of animal life as the tropical countries. The beasts of the forest decrease in numbers, size, and fierceness; and the wolf, the bear, the glutton, and the wild boar, are the only ferocious animals which thrive in these northern climates. In advancing on the desolate plains of Siberia to about the 60th degree of N. Lat., we find the cold still taking effect on the animal as on the vegetable creation, and the living creatures, as well as the plants and trees, stunted in their full proportions. Beyond this limit a different order of animals appears, protected against the severity of the climate by a thick covering of fur, which is sought after as a rich article of dress in more opulent countries. These animals are accordingly hunted for their skins, which constitute the great staple article of trade in Northern Asia. In the Arctic regions the bear seems to form the only exception to the diminished grandeur of the animal creation. This animal, nourished in the regions of Northern Asia, acquires a larger size, and far greater power and fierceness, than in southern climates. The domestic animals of the northern and mountainous countries of Asia are of a less imposing appearance, and not nearly of the same strength as those in the lower valleys of the S. and W. In the high and cold plains of Central Asia the camel is no longer used as a beast of burden, nor in the northern parts of the continent. Tibet and Central Asia, till beyond the Altaï Mountains, are inhabited by Mongolish and Turkish tribes, whose wealth consists in their cattle, which not only furnish them with food, clothing, and shelter, but are also used as beasts of burden, and in the labours of agriculture. The yak of Tartary, or the bushy-tailed bull of Tibet, seems to supply the place of the camel in these mountainous countries. This animal is about the size of a small bull, of great strength, and is reckoned a valuable property among the itinerant hordes of Tartars, to whom it affords the means of easy conveyance, of clothing, and shelter for their tents, from the prodigious quantity of long flowing glossy hair on its tail, and finally of subsistence from its milk and flesh. In those mountains is also found the musk-deer, which delights in the most intense cold, and of which the musk, a secretion by the male, affords a revenue to the government, as well as a valuable article of trade. Here, also, on the highest mountains, amid ice and snow, is the Cashmere goat, the wool of which affords the materials of the finest shawls.[3] Wild horses are seen in the high plains of Tibet; and the breed of sheep, a peculiar species of which is indigenous to the climate, is of great value. They are nourished on the short and dry herbage of these exposed plains, and serve for subsistence to the inhabitants, as well as for beasts of burden. The wild and extensive plains of Tartary are inhabited by pastoral tribes, who depend in like manner on their herds. On the southern side of the Altaï Mountains we find the same tribes of wanderers, most of them the scattered remnants of the Tartar nations who had formerly so deep a share in the great revolutions of Asia. All these tribes subsist chiefly by pasturage. Near the Ural mountains some live chiefly by hunting or ensnaring the elk and other wild animals for their furs. Among those who are shepherds sheep and horned cattle are found; while the hunting tribes have scarcely any domestic animals. In all these countries the wolf and the bear are known to abound. In the rigorous climate, farther to the N., where the cattle are stunted in size, and can scarcely subsist, their place is supplied by the reindeer, a species peculiar to a rigorous climate, and most valuable for all domestic purposes, whether for draught or for subsistence. During part of the year the inhabitants of those desolate countries subsist upon its flesh or milk, its skin furnishes them with the chief part of their dress, and its horns with such domestic utensils as they require. The dog is also trained to draw the sledge.

The feathered race in Asia includes almost every known species. In the southern parts are found all the tropical

[1] Elphinstone's *Account of Cabul*, chap. vi.

[2] *Ibid.* p. 143.

[3] Turner's *Embassy to Tibet*, p. 186.

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birds, distinguished by the most beautiful plumage, and some of them uttering sounds that have a resemblance to the human voice. Here are also found some of the largest and rarest birds,—the ostrich, the cassowary, and, in the Himalaya Mountains, the gypaëte, one of which, shot by a British officer, is stated by Bishop Heber to have measured from the extremity of one wing to another the enormous length of 14 feet. The other birds are eagles, kites, vultures, magpies in the higher countries, hawks, crows, wild geese and ducks, flamingos, herons, bustards, florikens, rock pigeons, lapwings, storks, plovers, snipes, quails, partridges, different species of *fringillidæ*, and almost all the other small birds to be found in similar climates. In Northern Asia the feathered creation is nearly the same as in Europe.

The principle of life, which is so active throughout the torrid zone, and produces quadrupeds of the most enormous size, is also visible in the magnitude and numbers of the reptile tribe, many of them armed with the most fatal poisons, all of them odious to the sight, and some, such as the Python Bivittatus, attaining the length of 20 feet, and of such prodigious muscular strength as to coil round and crush large animals to death. The influence of cold is adverse to the growth of large serpents, which are not found in Asia to the N. of the Altaï Mountains. The shark, which is found in all warm climates, haunts the tropical seas of Asia; and the crocodile, which is a different animal from the alligator of America, though equally powerful and ferocious, infests the rivers. Innumerable insects of every form, and most of them noxious and destructive, swarm in the torrid regions of this continent. During the short summers of Northern Asia, the musquito and other insects abound in the woody tracts of Siberia, insomuch that near the Ural Mountains the peasants burn constant fires before their cottages, as a defence against their attacks.[1] But the locust, which is common in certain parts of Asia, is the most mischievous of all these winged creatures. They light upon a country in a cloud which darkens the air, and leave nothing green behind them; fields sown with grain being utterly laid waste, and trees stript of their leaves, and of all power to ripen their fruits. They overspread the country with an appearance of blackness for many miles; and when they are driven by the winds into the sea, their dead bodies cover the shore in heaps. These destructive animals appear occasionally in the countries to the N. and W. of the Indus, in Beluchistan, in the desert tracts of Khorassan, and in Persia.[2] They are sometimes seen in Arabia in countless swarms; and frequently to the north of the Altai Mountains, at the sources of the Irtisch, whence they extend their destructive flight as far as the Crimea and the southern provinces of the Russian empire.[3]

Historical sketch of the Asiatic nations.

Asia has been subject to more awful revolutions than any other part of the world. Though it was at a very early period the seat of flourishing kingdoms, it was soon desolated by war. Its wealthy cities, sacked by their conquerors, fell into decay and ruin; and many of its countries, once civilized and populous, now languish in desolation from violence and misrule. The mighty revolutions which have shaken this continent form an interesting subject, on which volumes might be filled. All that we can propose is a historical sketch of the great leading events which distinguish the annals of Asia, with a brief notice of the various nations which have flourished, or are now to be found within its limits.

Nineveh; Babylon.

The early history of Asia, like that of all other countries, is lost in antiquity; and the obscurity is but slightly dissipated by the indistinct accounts which we receive from the Greek historians, and the brief notices in the Sacred Scriptures, of the Assyrian and Babylonian empires. According to the account of Ktesias, the Greek physician of Artaxerxes Mnemon, the Assyrian empire was founded by Ninus, about 2182 years before our era, and lasted during 13 centuries. Ninus is considered as the founder of Nineveh, and is said to have extended his dominion over all the regions between Bactria and Egypt. He was succeeded by his wife Semiramis, who is stated to have been the founder or enlarger of Babylon, and to have extended her conquests as far as India. To her succeeded her son Ninyas, after whom follow a long succession of more obscure sovereigns, whose very names, except in as far as they may yet be recovered by the recent discoveries at Nineveh, and of the key to the arrowheaded character, may be said to have perished. The last of the series was that Sardanapalus who immolated himself when his capital was taken by his revolted subjects, Arbaces governor of Media, and Belesis viceroy of Babylon, about 800 years before the Christian era. It seems proved, however, that notwithstanding this alleged termination of this empire, the Assyrians of Nineveh continued to possess considerable dominions for two centuries later; and in fact it was only in the eighth and seventh centuries B.C., that the monarchy attained to a very high degree of power under the kings whom the Hebrew Scriptures call Pul, Tiglath-pileser, Shalmaneser, Sennacherib, and Esarhaddon, who extended their empire over Syria, and destroyed the kingdom of Israel. But their power rapidly declined; and Nineveh was finally destroyed by the united Medes and Babylonians, about 606 years B.C.

In the Sacred Scriptures we read of Nimrod, "the mighty hunter," "the beginning of whose kingdom was Babel." But nothing more is said of him; and all the early history of Babel or Babylon is very uncertain. All that we know is, that it was the seat of a kingdom in the year 747 B.C.: for its ruler Nabonassar established a chronological era, commencing in that year; but we know not whether he was an independent sovereign, or a tributary prince under the empire of Nineveh. In the following century, however, the kingdom of Babylon was raised to a high pitch of grandeur by several able princes, who extended their dominion to the shores of the Mediterranean. Of these, the most powerful was Nebuchadnezzar, who overturned the kingdom of Judah, destroyed Jerusalem, and carried away the principal inhabitants captive to Babylon, about 600 years B.C. He so greatly embellished that city as to consider himself as its second founder: but its glories were ephemeral; for in a few years after his death, it was besieged and taken by the Medes and Persians under Cyrus; from which time it ceased to be the capital of an independent state.

The ancient Medes seem to have been a branch of the great Indo-European family of nations; but their early history is utterly unknown, except in as far as it may have been interwoven with that of the Persians; by whose annalists both are represented as having been the inhabitants of Iran, under the empire of Jemshid. Media afterwards seems to have fallen under the dominion of the Assyrian monarchs; but, according to Ktesias and others, its governor Arbaces revolted against his sovereign, and established an independent kingdom. The history of that revolution, however, is so obscure, that some authors have considered Arbaces as not merely founding a new kingdom for himself in Media, but as supplanting Sardanapalus on the Assyrian throne at Nineveh. However that may be, it is pretty certain that, within two centuries after the time of Arbaces, Media was still subject to the kings of Nineveh.

According to Herodotus, the Medes lived long in a state

[1] *Voyages de Pallas*, tome ii. p. 369. [2] Pottinger's *Journey through Belochistan*, p. 129; Elphinstone's *Account of Cabul*, p. 145.
[3] Pallas' *Travels through the Southern Provinces of the Russian Empire*, vol. ii. p. 426.

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of anarchy, till, tired of its evils, they chose for their king Deioces, a person who had acquired a great reputation among them for his just arbitration of their differences. Deioces built a fortified palace at Ecbatana, and established himself in the sovereign power of Media, which he transmitted to his descendants. His son and successor, Phraortes, engaging in a war with the Assyrians of Nineveh, was defeated and slain on the plain of Rogau. He was succeeded by his son Cyaxares, in whose reign the Scythians burst into the S.W. of Asia, and retained possession of Media for 28 years. On their expulsion, Cyaxares attacked the Assyrians; and, assisted by the king of Babylon, took and destroyed Nineveh, about 606 years B.C. He was succeeded by his son Astyages, in consequence of whose defeat by Cyrus, the empire was transferred from the Medes to the Persians, about 546 years B.C.

The Persians, like the Medes, appear to be a branch of the Indo-European family. Their early legends describe as their original seat a delightful country, enjoying a very mild climate, with seven months of summer weather. But Arimanes, the Genius of Evil, smote it with the plague of *cold*, so that it came to have ten months of winter, and only two of summer. In consequence, the people were compelled to seek other settlements, and, under the guidance of their sovereign or patriarchal leader, Jemshid, gradually found their way to the several fertile regions interspersed among the deserts that still cover a large portion of Persia. Their original country, of which Arimanes thus deprived them, is supposed by some to be the modern Turkistan; while others look for it in the opposite direction, in the modern Azerbijan. In the lapse of time the Persians were found occupying Persis, *Fars*, and also spread over the hilly and barren country extending towards the Indus and the Caspian. They seem to have been divided into many tribes, no less distinguished by their mode of life, than by diversity of rank. Three of them were considered as noble; and of these the Pasargadæ were the most illustrious. Of that noblest tribe, the most noble family was the Achæmenian; and to that family belonged Cyrus the founder, and Darius the establisher of the Persian empire.

Persia continued to rule over Asia for above 200 years, when its power was overthrown by Alexander the Great. His extensive conquests were divided among his generals, who renewed the strife for dominion which had been for a time extinguished by the ascendancy of Persia. Amid these contentions Parthia and Bactriana in the east rose to the rank of independent states. The Roman armies entered Asia about 200 years before the Christian era, and subduing all opposition, they finally established the dominion of Rome from the Hellespont to the eastern boundary of the Euphrates. By the decided triumph of this great power mankind obtained a fresh respite from the calamities of war. It was the first care of the Romans to cement by policy what they had gained by arms, and to establish order and tranquillity in all parts of their widely-extended territories. From this period, accordingly, may be dated the commencement of that brilliant era of prosperity and repose enjoyed by this portion of Western Asia for nearly 700 years, the time which elapsed from its final conquest by the Roman armies under Pompey to its subjugation by the Saracens in the 638th year of the Christian era. The people, profiting by the singular felicity of their lot, devoted their attention to commerce and the arts of peace, and attained to a high degree of wealth and refinement. All the civil institutions of society flourished; science and literature were cultivated; and mankind, basking in the sunshine of domestic repose, seemed to enjoy the illusion of perfect happiness. It is estimated that 500 populous cities covered the face of the country. These were adorned with magnificent temples and other splendid monuments of art; and some of them, such as Pergamus, Smyrna, Ephesus, &c., and especially Antioch and Alexandria, rivalled in extent and magnificence the majesty of Rome itself.[1]

Hindustan and China.

After an interval of 500 years, the Persian monarchy was revived under the dynasty of the Sassanides.[2] In Eastern Asia the splendid and populous empires of Hindustan and China, though imperfectly known in Europe, had flourished for many centuries. The origin of the Hindu power is buried in a remote antiquity. The first authentic notice of this truly remarkable people was brought to Europe by the officers who accompanied Alexander's expedition to India. Prior to the era of the Mahometan conquest, in the year 1000, the Hindus possess very imperfect materials for their history.[3] Hindustan comprehended then, as now, the extensive country bounded by the Indus on the W. and the Ganges on the E., though we know but little of its boundaries or internal state. The origin of the Chinese, as of other nations, is hid in obscurity. They claim their descent from a very high antiquity, their history going back by tradition to the remote period of 40 centuries, and for 2000 years their annals are verified by the testimony of contemporary historians. It is quite certain, indeed, that long before the Christian era they had emerged from the barbarism of pastoral life, and were devoted to agriculture and commerce; that they had acquired wealth and prosperity, and were thoroughly instructed in all the arts and refinements of civilized nations, as then known.

The pastoral tribes.

The historical sketch which we have given above includes only the civilized portion of Asia. But a great proportion of her population were in ancient times shepherds, who dwelt in tents; and it is the more necessary to attend to the distinction between these two classes, as it will be found to illustrate the political history of Asia, and those stupendous revolutions which have not only shaken this continent to its centre, but have been extended to the remotest parts of the world.

It has been already mentioned, that the vast table-lands of Central Asia, though containing large tracts of desert, are nevertheless interspersed with fertile and well-watered valleys, which produce abundance of pasture; and the immense plains to the N. of the Altaï Mountains, which extend over the whole breadth of the continent, from the Aldan Mountains E. of the Lena to the Urals, afford subsistence for innumerable herds of cattle. In all ages, accordingly, those plains have been inhabited by wandering tribes of shepherds, rude, ferocious, and delighting in war. It is finely observed by the Roman historian, that "the pastoral manners, which have been adorned with the fairest attributes of peace and innocence, are much better adapted to the fierce and cruel habits of a military life." Such, accordingly, has been the character of all the pastoral nations. They have been always addicted to violence and plunder; and their predatory expeditions, whether for the plunder of individuals or of empires, have been invariably conducted with the same fierceness and cruelty. In a pastoral state every man is a soldier, and he is trained to war by his daily occupations. He is hardened in his body by continual exercise and exposure to the weather; in hunting the wild animals of the forest, he acquires skill in horsemanship and in the use of all war like weapons; and in the perpetual migrations of his tribe, which must be carried on with the same order as the march of an army, he is trained to vigilance and discipline. These wandering barbarians were, besides, engaged, as may be easily supposed, in continual wars with each other. Here,

[1] Gibbon's *Decline and Fall of the Roman Empire*, chap. ii.

[2] Sir J. Malcolm's *History of Persia*, chap. iv.

[3] Rennel's *Memoir of a Map of Hindostan*.

as elsewhere, the usual scarcity of subsistence and of room would soon be experienced with the progress of population. Disputes would thence arise, and fierce contests, which would only terminate with the destruction of one or other of the contending tribes. Of such obscure wars we have no accurate account, though it is certain, that from time immemorial the work of mutual slaughter has been going on in the interior of Asia; and it is obvious that those vast multitudes, if they had been united under some able leader, who could compose or crush all domestic dissensions, might, in place of wasting their strength in intestine strife, have directed it against the civilized portion of the earth, where wealth presented a tempting prize to barbarian cupidity; and, accordingly, this was precisely the calamity by which mankind were at length overtaken. The world was to be disturbed by a conflict, not as heretofore between improved states, but between barbarism and refinement. The question was now to be decided, whether polished nations or barbarians should rule the world; whether literature, science, the arts, the improved institutions, and the whole order of civilized society, should be broken up and buried under an overrunning flood of savage hostility. From the earliest times the countries of Asia Minor, and some parts of Europe, were subjected to the irruptions of barbarians; but no permanent conquest was ever attempted, and the invaders were in general quickly repelled. Asia Minor was defended against the inroads of the Scythians by the Persian monarch; and Rome, in the lion-like vigour of her growing strength, quickly shook off such unequal adversaries. Whether, however, from the increasing population of the Asiatic plains, or from the greater political union of the different tribes, those attacks were renewed with more vigour than ever; and at times the mighty mass of population over the whole breadth of the continent seemed to be agitated by one movement; and, according as the impulse given was to the E. or to the W., the kingdoms of Europe or the empires of Hindustan and China were swept by the tempest of invasion. Those formidable expeditions were attended with various results. In those states which were vigorously ruled, the discipline and tactics of civilized warriors proved an overmatch for the untutored valour of barbarians. But, on the other hand, when the people, enervated by ease and luxury, neglected the study of war, and trusted for safety to a mercenary force, the country was overwhelmed by its barbarian conquerors. The Chinese empire was overturned about 200 years before the Christian era, by an irruption of the Huns; the fertile countries on the banks of the Oxus, and of the Jaxartes as far as the Caspian Sea, which had attained to wealth and prosperity under the Macedonian kings, and had ever since been cultivated like a garden, were reduced by the white Huns, and under their sway Kharisme, Bokhara, and Samarcand became the seats of industry and of flourishing manufactures, and the great marts of the Indian and European commerce; while the Roman territory in the W. was repeatedly assailed, and finally overturned, by hosts of barbarians, who had quitted the crowded plains of Asia in quest of settlements to be won at the point of the sword.

Mahometan power.

It was about the middle of the seventh century that the Mahometan power emerged from the Arabian deserts; and the shepherds of those burning plains, inflamed by religious enthusiasm and the love of plunder, were equally formidable in war with their brethren of the north. Of all the invaders who, in this unhappy period, desolated the world, the Arabian tribes were the most fierce and cruel. Their religion enjoined the blindest intolerance; they were commanded to propagate their faith by the sword; and it was accounted a merit in a true believer to shed torrents of infidel blood. The track of Mahometan invasion was accordingly marked by the ruin of peaceful cities and by unsparing slaughter. In the course of two years the plain and valley of Syria was subdued by the Arabs or Saracens, whose conquests were soon extended over Asia Minor in the W. and Persia in the E.; and the country of Transoxiana, or the fertile plains lying on the Oxus and the Jaxartes, were, after several severe battles, reduced under the power of the khalifs, whose authority, a century after the flight of Mahomet from Mecca, in the year 622, extended in Asia about 200 days' journey from E. to W., from the confines of Tartary and India to the shores of the Hellespont, and in Europe and Africa as far W. as the Atlantic Ocean.

The dominions of the Arabian princes, in their widest extent, were divided into provinces, under subordinate governors, who owned themselves the servants or slaves of the khalif at Baghdad, their temporal as well as spiritual ruler. In the decay of the supreme power, those rulers, under the forms of the most abject submission, had acquired independence; and the khalif remained at Baghdad the vain object of outward homage, while he was inwardly despised. The Persian kingdom was also detached from their dominion, being usurped by a new dynasty, and was extended from the Caspian Sea to the ocean. This dynasty, as usually happens in disorderly times, was supplanted by two families, who, making a division of the kingdom, ruled, the one over Khorassan, Seistan, the high plains of Balk on the northern side of the great Himalaya ridge, and the countries of Transoxiana, with the cities of Bokhara and Samarcand; and the other over the southern provinces of Persia, as far as the Persian Gulf, namely, Irak, Fars, Kerman, Khusistan, and Laristan. These families appear to have ruled in Persia for 125 years, namely, from 874 to 999. They were overthrown by the Turkish princes of the line of the Ghuznevides, the founder of which was Subuctageen or Sebectagi, who, from a common soldier, rose to the rank of a petty prince, and fixed his residence at Ghuzni. His dominions consisted chiefly of the tract of country which, after the division of Alexander's empire, composed the kingdom of Bactria, namely, the countries lying between the Caspian Sea and the Indus, and near the source of the Oxus. He invaded Hindustan, subdued Northern India and the province of the Punjaub, and rendered the princes of the countries tributary to the princes of Ghuzni.[1] His son Mahmoud of Ghuzni, who reigned in Persia about 1000 years after the birth of Christ, was still more famous for the extent of his conquests. He had extended his empire northward by the reduction of Bokhara; and he now determined, in the true spirit of Mahometan intolerance, to wage a holy war against the idolaters of Hindustan. At this period the Mahometans had effected no permanent settlement in Hindustan. The people were purely Hindu, without any admixture of foreign manners; and the whole country along the E. side of the Indus to Cashmere was ruled by a prince of the Brahmin race, and between whom and the kings of Delhi, Ajmere, Canoge, and Callinger, a confederacy was now formed against the common enemy of their country and religion.[2] Mahmoud entered Hindustan in A.D. 1000, and having defeated the armies of the confederate kings, he reduced the province of Moultan. Eight years afterwards he penetrated into the heart of India, where his farther progress was opposed by the confederated princes of the country, from the Ganges westward to the Neerbuddah. But the fanatical invader was still victorious, and his progress was signalized by rapine and slaughter. The idols were all broken to

[1] Sir J. Malcolm's *History of Persia*, chap. vii.

[2] See *Memoir of a Map of Hindostan*, xliv. Major Rennel's elaborate and masterly researches have thrown great light on the geography of this interesting portion of Asia.

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pieces, the temples, many of them of the most beautiful architecture, were pulled down, and an immense spoil was carried away. In the course of his twelve expeditions into India Mahmoud extended his conquests to the Ganges; and when he died, in 1028, his territories were of great extent. The annals of those disorderly times afford no very accurate data for ascertaining their exact limits, which are variously stated by writers of great authority. According to Major Rennel, the empire which he established comprehended the eastern, and by much the largest part of Persia, and extended nominally from the upper and western course of the Ganges to the peninsula of Guzerat, and from the Indus to the mountains of Ajmere in Northern India.[1] Sir J. Malcolm assigns Georgia and Baghdad for its limits on the W. and S.W.; Bokhara and Cashgar on the N. and N.E.; and Bengal and the Deccan, as far as the Indian Ocean, to the E. and S.E. But though a large portion of Hindustan was at this time overrun by the Mahometan armies, it was only the Punjaub, or the country of the Five Rivers, that was entirely reduced under any regular government, the other parts of the country being merely occupied by troops.

Turkish tribes.

The empire of Mahmoud declined after his death, owing to divisions and civil wars, but chiefly to the rise of the great Turkish tribe of the Seljookee, which was so called from the name of their renowned chief Seljook, who, being banished by his khan or chief from Turkistan, passed the Jaxartes with his numerous followers, and settled in the plains of Bokhara, in the neighbourhood of Samarcand, where he embraced the Mahometan religion. It is only when those barbarous hordes emerge from the desert, and come into contact with civilized life, that we obtain any clear account of their migrations and history. Their contests with each other, and their obscure wanderings in the interior, are not chronicled among themselves, and are seldom known to other nations. Hence we have rarely any clear data for tracing their origin, or their early conquests, or the consolidation of many tribes into one great nation. It is certain, however, that the vast population of Asia, agitated by internal tempests, has been always violently driven on the great empires of China and Hindustan, or on those of Persia and Rome, and has either made a breach, or, if repelled, has assailed the civilized world at some other more vulnerable point. China has been in all ages an object of attack; and it is generally believed that the Turks, and especially that tribe of them under Seljook, had been driven by the Chinese and a tribe of Tartars from the high plains of Asia, a short time before they sought refuge in the provinces of Transoxiana. They were living near the territories of Bokhara when they first attracted the notice of the Sultan Mahmoud, the founder of the dynasty of the Ghuznevides, who had advanced into Bokhara with his army, and was so impressed with the fine military qualities of their chief, the son of Seljook, that he induced them to cross the Oxus and to occupy the country of Khorassan.[2] He had soon reason to repent of this fatal error. Like all those wandering hordes, the Turkomans were shepherds or robbers. They either molested the neighbouring states by petty inroads, or, with the whole united force of the nation, they practised robbery on the great scale, seizing on kingdoms and despoiling nations. The first migration of these eastern Turkomans is generally fixed in the tenth century. They became formidable to Mahmoud, and more especially to his successor Massoud, who, from inability to resist their progress, was forced to grant them lands. He was afterwards defeated by them in a general battle; and the victorious Turks, under their leader Togrul Beg, whom they had now elected king, invaded Khorassan, and finally expelled the Ghuznevides, the descendants of Mahmoud, from the eastern provinces of Persia. They fled eastward towards the Indus, and established the Ghuznian empire in the north-western provinces of India. This empire was maintained with various success till about the year 1184, under the Ghuznian emperors.[3] It is difficult to give any accurate view of its limits, which in such turbulent times would naturally vary with the fortune of war. They appear to have embraced the eastern parts of Persia, the mountain country of Kabul or Afghanistan, and the Indian provinces of Lahore and Moultan. The Ghuznian dynasty was superseded by that of the Afghan or the Patan emperors, who completed the conquest of the greatest part of Hindustan Proper about the year 1210. Togrul Beg hastened to improve his victory over the Persian monarch. Turning his arms to the W., he invaded Irak, in the centre of Persia, and advancing westward of the Caspian Sea into Azerbijan, the ancient Media, he made his first approaches to the confines of the Roman empire. He afterwards proceeded to Baghdad, and by his conquest of that place gained possession of the person of the khalif, who was treated with the most profound veneration. His successors Alp Arslan and Malek Shah extended the empire transmitted to them by Togrul Beg. They subdued the fairest portion of Asia. Jerusalem and the Holy Land, which flourished under the mild sway of the khalifs, was taken and pillaged by one of the lieutenants of Malek Shah; and it was the vexation and rapine to which the Christian pilgrims were exposed in their journey to Jerusalem under the barbarous rule of the house of Seljook, that inflamed the indignation of the Christian powers, and gave rise to those wild and warlike expeditions for the recovery of the Holy Land, known under the name of the Crusades. The empire of the Seljookian Turks extended, under Malek Shah, from Egypt and Syria to Bokhara, which he conquered as far as Samarcand and Kharisme. He received homage from the tribes beyond the Jaxartes, and compelled the sovereign of Cashgar to offer up public prayers for his prosperity, to strike money in his name, and to pay him an annual tribute.[4]

Asia. A.D. 1037.

Internal wars.

From this period till the invasion of Zinghis or Ghenghis Khan, which is 110 years, namely, from 1092 to 1202, Asia was convulsed by foreign and intestine wars. The death of Malek Shah dissolved the unity of his extensive empire, in which three new dynasties arose; while in many cases the provincial governors contended for supreme authority, and harassed the country by their mutual wars. It was during this era of division and weakness that Asia Minor, which was ruled by the dynasties of Iconium and Aleppo, was invaded by the hosts of the European crusaders, who rapidly subdued the country, took the holy city of Jerusalem, and extending their conquests over the hills of Armenia and the plains of Mesopotamia, founded the first principality of the Franks or Latins, which subsisted 54 years, beyond the Euphrates. Those European invaders retained possession of Asia Minor and of Syria for nearly 200 years. Exhausted at length by a long series of sanguinary wars, and not receiving reinforcements from home, they were finally driven from all their conquests by the coalition of the Turkish powers.

The Turkish dynasty of the Seljooks continued for 158 years, or 215 years if we reckon from the time that the tribe first emerged from the desert under its leader Seljook. The sultan of Carisme or Kharisme, who ruled over the country

[1] Major Rennel's *Memoir of a Map of Hindostan*, xlvi.
[2] De Guignes, *Histoire Generale des Huns, des Turcs*, &c. tome iii. livre 10.
[3] Dow's *History of Hindostan*, vol. i. p. 142; Major Rennel's *Memoir of a Map of Hindostan*, cxli.
[4] D'Herbelot; De Guignes, *Histoire des Huns*, tome iii. livre 14.

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situated between the Oxus and the Jaxartes[1] with delegated authority, profiting by the distractions of the neighbouring kingdoms, declared himself independent, and invading Persia with a powerful force, he defeated and slew the last of the Seljookian monarchs, and subdued the greater portion of their dominions. He extended his inroads over Syria, and had become the terror of the Ayoubite princes and the sultans of Iconium; and he finally established his wide dominions from the Persian Gulf to the borders of India and Turkistan.[2]

Zinghis Khan.

The continued irruptions of those barbarous tribes into the regions of civilization had given rise to scenes of calamity and of revolution hitherto unequalled in the history of the world. Conquests had no doubt been achieved before by the warlike nations of antiquity, and the rage of war had been satiated by the ruin of peaceful cities and the massacre of the people. But these evils, great as they were, fell far short of those inflicted on mankind by the conquests of the pastoral tribes, which were carried to such a height by Zinghis Khan and his destroying bands, as nearly to threaten the desolation of the earth, and the extinction of all the arts, improvements, and civil institutions of society. This Tartar chief, or savage, who was originally the khan of a horde of shepherds, comprising 30,000 or 40,000 families, inhabiting the countries to the N. of China, seems, about the beginning of the thirteenth century, to have united under his sway all the other tribes which, under the various designations of Huns, Turks, Moguls, or Tartars, wander on the spacious high lands and plains of Asia, between China, Siberia, and the Caspian Sea. He became, to use the expressive language of the great historian of Rome, "the monarch of the pastoral world, the lord of many millions of shepherds and soldiers, who felt their united strength, and were impatient to rush on the mild and wealthy climates of the S." This great conqueror swept over the whole breadth of the earth with his barbarian hordes. Art and nature were found alike unequal to stay his destructive course. He traversed mountains and rivers, barren deserts and unhealthy climates, with resistless speed; and he oppressed the walled towns by his countless multitudes. The Chinese were the first enemies with whom, after quitting the desert, he measured his strength. His innumerable squadrons penetrated at all points the feeble rampart of the great wall. Ninety-six cities were plundered and destroyed, and the smaller towns and villages were reduced to ashes; the aged were given up to the destroying sword; a prodigious multitude of children were carried away, who were afterwards massacred in the march homeward; besides a rich spoil in gold, silver, silk, and cattle.[3] In a second expedition he was equally successful; the emperor fled before his enemies to a more southern residence; Yenking or Peking was taken and burnt; and, through the weakness and division of the Chinese councils, the five northern provinces of the empire were reduced under the dominion of the Moguls.[4] The invincible arms of Zinghis were now turned against the sultan of Kharisme, who, as has been already mentioned, ruled over the fertile countries situated between the Oxus and the Jaxartes, and had extended his conquests over a great part of Persia. At this period his territories contained the flourishing and commercial cities of Samarcand, Bokhara, Kharisme, Herat, Balk, &c. His troops were overpowered in a bloody conflict with the Tartar host, the country was subdued, and the rights of conquest were as usual most savagely abused. The open country was desolated, the rich cities plundered, and the inhabitants either slaughtered or carried into captivity; and in some cases everything that had life, with the city itself, was destroyed. The cities that perished in this general ruin were, Bokhara, situated on a branch of the Jaxartes, a populous city, the centre of an extensive commerce, and the seat of science and religion; Otrar; Cojend, on the Oxus; Samarcand, situated near the source of the same river as Bokhara; Kharisme, where 100,000 men were massacred, and the surviving population reduced to slavery; Balk, to the S. of the Upper Oxus, which contained 200 splendid mosques, and a numerous population; Nisabaur; Herat, in Khorassan; Candahar, farther E.; besides numerous other smaller towns and villages. All that tract of country which extends from the Caspian Sea to the Indus, comprehending the ancient territories of Transoxiana, Kharisme, and Khorassan, and which was fertile, populous, and well cultivated, was entirely ruined by this irruption of the Tartars, so that, to use the words of the historian of Rome, "five centuries have not been sufficient to repair the ravages of four years." The conquests of Zinghis, before his death, extended W. from the Indus to the Euxine, from the Pacific Ocean to the Volga, and from the Persian Gulf to the confines of Siberia. A.D. 1227.

The children of Zinghis, who succeeded him, completed the career of conquest which he had begun. China, divided at that time into the two dynasties or empires of the N. and S., was subdued and laid waste by his grandson Khublai, with all the unrelenting cruelty of a Tartar conqueror; and he extended his influence and the terror of his arms over the circumjacent kingdoms of Corea, Tonquin, Cochin-China, Pegu, Bengal, and Tibet. A new dynasty of Mogul princes was established in China, under whose sway the country gradually settled; and in the succeeding generation the habits of the invaders were mollified by the influence of civilized life. Letters, commerce, and the arts of peace were revived, and the ancient system and machine of Chinese manners and policy resumed its accustomed action. One hundred and forty years after the death of Zinghis, his degenerate race were expelled by a revolt of the Chinese, and the native dynasty of princes, namely, that of Ming, was elevated to the vacant throne.

Persia was overwhelmed by the invasion of the Tartar armies under Holagou Khan, the grandson of Zinghis. The princes who ruled in the different districts of the country, under the titles of sultans, emirs, and attabeks, were successively crushed under this great conqueror, who, advancing to the Euphrates, stormed and destroyed the city of Baghdad, put the khalif to death, and thus for ever extinguished the line of the Abassides. Syria was overflowed by the torrent of invasion; Damascus and Aleppo were given up to pillage;[5] the kingdoms of Armenia and Anatolia were overthrown; and the sultans of Iconium, the last remnant of the Seljookian dynasty, were extirpated by the armies of Holagou. A. D. 1243.

The descendants of Zinghis had no sooner subverted the empire of China, than they resolved on the conquest of the Western World; and collecting a mighty host, they advanced from China to Europe, inundating the intervening space with their innumerable hordes, and extirpating the reigning powers in Turkistan, Tartary, and the northern plains of Asia. They penetrated into Europe with their victorious armies, of which detachments were sent northward to contend with the Russian princes for the frozen regions of Tartary. The unity

[1] De Guignes, in his learned and laborious work *Histoire des Huns*, gives a very clear narrative of the situation and boundaries of this kingdom, and of its final ruin by the invasion of Zinghis Khan. The fate of the sultan, formerly a conqueror, who, flying from the Tartar horse, took refuge in an isle in the Caspian Sea, where he requested a horse might be allowed to feed near his tent, as the companion of his solitude, and his solace in adversity, is particularly touching. See tome iii. livre 14.

[2] De Guignes, *Histoire des Huns*, tome iii. livre 10.

[3] *Ibid.* tome iv. livre 15.

[4] Gibbon, vol. xi. chap. 64.

[5] "Les hommes," says De Guignes (tome iv. livre 17), "les femmes, et meme les enfans à la mammelle, furent égorgés."

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of the Mogul Empire, so firmly maintained by Zinghis Khan, was weakened by the extent of its conquests. According to its original constitution, all the other khans were the dependents or vassals of the great khan, under whose investiture they held their authority. But by distance, and the various mutations of time, those ties of allegiance were gradually loosened. The different branches of the Mogul family conformed, from policy or conviction, to the religion of the conquered countries, those who ruled in China to the idolatry of the Chinese, and the invaders of the Moslem territories to the Mahometan faith; and from this diversity of religion and manners divisions arose, which terminated in a lasting disunion. From A.D. 1240 till the rise of Timour or Tamerlane, about the year 1360, the Mogul power in Western Asia was shaken by intestine strife; and a crowd of emirs, sultans, and petty rulers contended, in incessant wars, for the fragments of the broken empire; while such of the Moslem potentates as survived the invasion of Zinghis, still maintained, by their valour, the balance of power in Syria against their Tartar enemies. The Ottoman line of princes, the permanent rulers of the country, were in the meantime slowly emerging into view. Amid the anarchy which reigned in Western Asia from the downfall of independent powers, and the rise of usurpers in their place, the country swarmed with a warlike population, with loose disbanded soldiers, and adventurers of every description. Among these were many of the Turkish hordes who had formerly pitched their tents on the southern banks of the Oxus, and the khan of one of those obscure tribes was the father of the Ottoman dynasty. Othman was the first of this line who, about the year 1326, by his conquests, laid the foundation of the Turkish Empire, which has ever since continued to rule in Syria and Asia Minor. About the year 1400 the Turks, under Bajazet, had acquired an extensive empire, the glory of which was for a time obscured by the conquests of Timour the Tartar, or Tamerlane, who began to acquire renown by his early conquests in Eastern Turkistan, or Transoxiana, about the year 1360, when he subdued the kingdom of Cashgar, and carried his conquests 480 leagues to the N.E. of Samarcand.[1] He finally extended his dominion to the Irtisch and the Volga; and in 1398, having previously reduced the Punjaub and the province of Moultan, he advanced across the intervening desert to Delhi, which submitted to his arms, and was abandoned to pillage. He proceeded northward towards the sources of the Ganges in a crusade against the idolatry of the Hindus, who were massacred without pity; and, after an expedition of five months, he finally retraced his steps to Samarcand, without effecting any permanent conquest. In the western countries of Asia he encamped and overthrew the rising power of the Turks under Bajazet, and extended his conquests over Syria and Asia Minor, giving over its flourishing cities, such as Aleppo, Damascus, Smyrna, &c., to the sword and the flame. The rise and progress of this great Tartar chief, and his rapid successes, rivalled those of Zinghis himself; but they were not on the same vast scale, nor had they such lasting effects. The kingdoms which were conquered by Zinghis were colonized by his soldiers and inherited by his children; but Tamerlane's conquests were more like predatory inroads; and though for the time he subverted the existing order of things, and trampled in the dust the princedoms and powers of the country, yet, as the flood of his invasion receded, those powers quickly resumed their sway. In Asia Minor the Ottomans speedily regained their ascendancy on the ruins of the Greek power. They reared up, in the middle of the fifteenth century, the permanent fabric of their empire. Towards the end of the same century Persia was, by a singular revolution, transferred from the Tartar chiefs to the dynasty of Seffavean kings, or saints as they were considered before their elevation to the throne. Under their rule the country continued without any material change, until it was invaded in 1722, and conquered by Mahmoud, the first of the Afghan rulers of Persia. The independence of Persia was vindicated by the rise of the celebrated usurper Nadir Shah, who, ascending the throne about the year 1730, quelled all internal dissensions, and re-established the Persian empire in its ancient greatness and glory. He restrained the Turks within the western boundary of the Euphrates; on the N. he extended his dominions to the Oxus, and awed by the terror of his arms the Usbecs and other wandering tribes of the desert; and on the E. he conquered Hindustan, which he plundered of its wealth, and fixed the Indus as the boundary of his empire. Under his successors Persia has decreased in extent of territory and in power, but has not been subjected to any violent revolution, and still continues one of the independent though declining empires of the E. In 1747 the Afghans, under the new dynasty of the Doorannee kings, resumed their independence, which they still retain. But the Doorannee Empire, which at one time extended over a vast region between the Oxus and the Indus, touching Persia and Hindustan, has melted away into several minor states.

Hindustan.

In Hindustan the influence of the Mahometan conquerors, which was firmly established in 1210, was gradually extended over the southern provinces, amid rebellion and massacre. The uncertain dominion of the country appears to have been shared among a crowd of tributary princes, who, from their intestine quarrels, became an easy prey to the invader. Delhi was the capital of the Mahometans; and their conquests were extended over Malwah, the Deccan (by which we mean the country between the Nerbuddah and the Krisna Rivers) and the Carnatic, which was ravaged from sea to sea. The invasion, or rather the predatory inroad, of Timour in 1398, did not subvert the Mahometan dynasty, which terminated in 1413 by the death of the monarch. The throne was then filled by a Seid, *i. e.* one of the race of Mahomet, whose posterity enjoyed it till the year 1450, when an Afghan took possession of it, and all Hindustan was divided into separate governments. After an interval of reviving prosperity, the empire, about the year 1516, fell again into utter confusion, which paved the way for the conquest of the country by Sultan Baber, a descendant of Tamerlane and of Zinghis Khan, who being driven from the provinces situated between the Indus and Samarcand, over which he reigned, determined to try his fortune in India. He crossed the Indus in 1518, and having defeated the emperor of Delhi, he established the dynasty of Timur, or the Mogul line as it has been termed, which was illustrated by two of the greatest princes that ever reigned in India, namely, 1*st*, Akbar, who, from 1555, reigned 51 years, and subjected to his sway all the provinces that had revolted, from Ajmere to Bengal; and, 2*dly*, by Aurungzebe, who, after deposing and imprisoning his father, the feeble Jehem Shah, the grandson of Akbar, ascended the throne in 1660, and died in 1707, in the 90th year of his age. In this reign the dominion of the Moguls was extended over the Deccan, the whole of which, excepting only the mountainous and inaccessible parts, was either entirely subjected, or rendered tributary to the court of Delhi.[2] His authority reached from the 10th to the 35th degree of latitude, and to nearly the same extent in longitude; and his revenue amounted to 32 millions sterling. The Mogul empire gradually fell to pieces under a succession of feeble princes; and about the year 1750 it was reduced to the city

[1] Gibbon, vol. xii. chap. 65.
[2] Dow's *History of Hindostan*, vol. ii.; Major Rennel, *Memoir of a Map of Hindostan*, Introduction, lxl.

of Delhi and a small tract of adjacent territory. The last imperial army that ever appeared in the field was defeated by the Rohillas in 1749; and during this period the whole country was one scene of commotion, all the viceroys and petty feudatories of the Delhi sovereigns,—the various mountain tribes, such as the Rajpoots, who ruled in Ajmere,—the Sikhs, who had become formidable, and had established themselves in Lahore,—and the Jats, a tribe also in the north of India,—contending in arms for independence. Nothing remains of Mogul greatness but the name, which was, and still is, used as the symbol of sovereignty, and the sanction of all political and civil rights.

The decline of the Mogul empire paved the way for the rise of the Mahratta power, which had already become formidable in India under its founder Sevajee. At his death in 1680 he had acquired considerable dominion on the western coast of India. The confusion and anarchy that followed the death of Aurungzebe greatly facilitated the Mahratta conquests; and in 1740 this growing empire, which was divided between two chiefs, the one residing at Poonah in the west, and the other at Nagpoor in the east, occupied the whole tract from the western sea to Orissa, and from Agra to the Carnatic.[1] The Mahrattas, thus daily gathering strength, and the Mahometans, were now the two great rival powers in Hindustan. The contest between them was brought to an issue in the memorable battle of Paniput in 1761, when the Mahratta host of 200,000 men was entirely overthrown, with the loss of the greater part of their army, and their best generals; and from that fatal day their power began to decline.

Rise of the British power.

The rise of the British power forms an important era in the history of India. The unwarlike inhabitants of Hindustan, successively subdued by the Greek, the Mahometan, and the Tartar armies, were now destined even more surely to fall under the science and discipline of Europe. The French maintained their ground in India only for the short period of 12 years, from 1749 to 1761. The British, who engaged about the same time in the wars and politics of India, were more successful. The battle of Plassy, in 1757, fought with Surajah Dowlah, nabob of Bengal, gave them a firm footing in the country. The war which followed terminated in their favour; and in 1765 they acquired the right of collecting the revenues of Bengal, which was in fact equivalent to the sovereignty of the country. The jealousies of the native powers, excited by the encroachments of the Europeans, gave rise to new contests. But victory was still the result of each new struggle; and all the wars undertaken against the British only tended to consolidate and enlarge their empire. The British dominions in India may now be said to extend, with little interruption, from the banks of the Indus to the frontiers of Burmah, and from Cape Comorin to the Himalaya. Our actual possessions in that country may be roughly estimated to comprise an area of 750,000 square miles, with a population of 100 millions. See HINDUSTAN.

Different Asiatic races.

Amid those revolutions, of which we have attempted to give a brief sketch, it is not surprising that some of the most ancient empires of Asia should have entirely disappeared; that populous cities should have fallen into decay and ruin; and that extensive countries, once the seats of wealth, commerce, and science, should now lie desolate. The Babylonians and Assyrians have been long blotted out of the page of history; and no traces of them remain in the population of the world. The kingdom of the Jews has also been overthrown; but this ancient race are still wanderers on the face of the earth, and are found in most parts of Asia. There are other five principal races, who, it is remarked by Sir W. Jones, have in different ages divided among themselves as a kind of inheritance, and who still occupy, the vast continent of Asia, with the many islands depending on it. These are the Hindus, the Chinese, the Tartars, the Arabs, and the Persians. The origin of those different races is a curious subject of inquiry, and must be sought for in the remotest antiquity, and from the doubtful analogies supplied by religion, manners, and language. Sir W. Jones, who has so well illustrated many obscure points of ancient history, is of opinion that Persia was the original seat of mankind, from which, as from a common centre, they have gradually spread over the earth. According to his learned hypothesis, deduced from ancient works and an examination of the primitive languages, a flourishing empire was established in Persia or Iran, in the earliest dawn of history; and the population consisted of the three distinct races of Hindus, Arabs, and Tartars. About the era of Mahomet, it appears that, besides the language in common use, the learned had a language of their own, which had the name of the Pahlavi; and there was the still more ancient and abstruse language of the Zend, in which some sacred books were written, only known to a sect of priests and philosophers. The Pahlavi he clearly proves to be of Chaldaic origin, and the Zend, from an imperfect vocabulary which he procured, to be a dialect of the Sanscrit, the ancient and learned tongue of the Brahmins in India. Having thus ascertained the analogy between the language of the ancient Persians and that of the Arabs and the Hindus, he concludes that they must have originally been the same nation; and that, as Persia could not be peopled from the east by the Hindus, whose religion forbids them to emigrate, nor by the Arabs from the west, as we have not the slightest tradition of any such emigration, both Arabs and Hindus must have come from Persia, since we may still trace in this country the remains of their respective tongues, all of which appear to have been derived from one common and more ancient root.

The people of Tibet are descended from the Hindus, and, according to the hypothesis of Sir W. Jones, who, on all those subjects unites solid reasoning with the most profound learning, have engrafted the doctrines of Buddha on their ancient religion. Their language, though it has been corrupted by an intercourse with the Chinese, still bears the traces of a Sanscrit origin. The Afghans or Patans, who occupy Afghanistan between Persia and Hindustan, are said to have sprung originally from the Jews; but their language, which is evidently of the Indo-European root, does not warrant this tradition. The Japanese and the Chinese are evidently derived from a common stock, their literature, religion, and manners being the same. The Burmese are considered by some ethnologists to belong to the Hindu race, though others give them a Tartar origin.

The Tartars or Tatars, under which appellation we include the hordes of shepherds who range over the vast plains of Asia, under the names of Scythians, Huns, Mongols, and Kalmucs, differ entirely from the Hindus and Arabs in features, complexion, and form, as well as in manners and language, and appear evidently to be a distinct race. Their language, which is the Turci or the Turki, of which the modern Turkish is a dialect, might, according to Sir W Jones, be easily traced to a different root from the others. This ancient Tartarian language he mentions, on grounds which it would not be easy to disprove, was current in Persia at a very early age; and hence he concludes that the Tartars formed part of the ancient population of Persia, and, along with the other two races, issued from that country to occupy the deserts of Asia. The Chinese, according to the same learned author, whose opinion is founded on the Sanscrit institutes of Menu, were originally a military tribe of the Hindus, who, abandoning the ordinances of the Brahmin

[1] Major Rennel, Introduction, lxxxv.

religion, and living in a state of degradation, emigrated eastward, and occupying the countries bordering on Hindustan, laid the foundation of the Chinese empire. But the whole country has been since overrun and conquered by hordes of Tartars; and from the intermixture of those two races have sprung the modern Chinese, whose coarse, broad, and Tartar-like physiognomy bears no longer the traces of their Hindu ancestry.

The tribes who inhabit the great Asiatic archipelago, which extends from Madagascar to the Philippines and the neighbouring peninsula of Malacca, bear in their features, language, and customs, the undoubted marks of the same origin; and as the Sanscrit may be traced as the root of most of the dialects spoken in these islands, they appear to be descended from the Hindus. But in the lapse of ages and in the various chances of war or migration, different nations may be intermingled; the original traits by which each was distinguished will then gradually disappear, so that it may not be possible to discern the traces of a common origin in the varieties of the same race. It is possible that the inhabitants of the great Indian archipelago may have come originally from Hindustan, bringing with them the Sanscrit tongue; although it is probable that they are sprung from the same stock as the people of the adjacent regions. Sir Stamford Raffles, not less distinguished by his eminence in eastern literature and antiquities than as a legislator and a statesman, is of opinion that the Asiatic islands were peopled from that portion of the continent which lies between Siam and China. "The less civilized of the tribes," he observes, "inhabiting the islands, approach so nearly in physical appearance to that portion of the inhabitants of the peninsula which has felt least of the Chinese influence on the one side, and of the Burman and Siamese on the other, and exhibit so striking an affinity in their usages and customs, as to warrant the hypothesis, that the tide of population originally flowed toward the islands from that quarter of the continent lying between Siam and China. But at what era this migration commenced—whether, in the first instance, it was purely accidental, and subsequently gradual, or whether originally it was undertaken from design, and accelerated at any particular periods by political convulsions on the continent, we cannot at present determine, as we have no data on which to rely with confidence. It is probable, however, that these islands were peopled at a very remote period, and long before the Burman and Siamese nations rose into notice."[1] Mr J. Crauford, who resided for nine years in the Asiatic islands, and whose history of those countries displays extensive research, and a profound knowledge of Eastern literature and antiquities, adopts a different hypothesis respecting the original population of the Indian archipelago. He describes the original inhabitants as consisting of two races, one a brown-complexioned people, with lank hair, and in their persons short, squat, and robust, supposed by other writers to be Tartars; and the other, a negro race, of a puny stature and feeble frame, in complexion black, or rather sooty-coloured, with woolly or frizzled hair. The brown-coloured race compose the civilized portion of the people; and they have supplanted the negroes, who are constantly found in a savage state in Sumatra, Java, and Celebes, where civilization has made the greatest progress; while in New Guinea and other islands the negroes are almost the sole inhabitants. The origin of these two races, and the period when they settled in the Asiatic islands, is, according to Mr Crauford, buried in the remotest antiquity. The Tartar origin of the one race, though supported by many writers of learning, and the African origin of the negroes, is treated by him as absurd and unfounded. "Either hypothesis," he observes, "is too absurd to bear the slightest touch of examination. Not to say that each race is radically distinct from the stock from which it is imagined to have proceeded; the physical state of the globe, the nature of man, and all that we know of his history, must be overturned to render these violent suppositions possible." Dr F. Buchanan, Sir Stamford Raffles, and others, deduced the Tartar origin of those insular tribes from their form and features, which is the best evidence we can have where history is silent. The prevalence of the Sanscrit language in these islands has also, and with apparently some reason, been supposed to indicate the quarter from which the tide of population flowed; nor is it easy to see how the migration of a people from the continent of Asia into this archipelago is at variance with the "physical state of the globe, the nature of man, and all that we know of his history." Mr Crauford traces the various languages of the Asiatic islands to one common root. From this fact he concludes those islanders to have all sprung from one source, and he fixes on Java as their original place of settlement. Here he supposes they took up their abode when they were little better than wandering savages; whence they gradually spread over the other islands. Now it is on the same ground that others trace their origin to some continental nation of great antiquity. The language of a nation may throw light on its origin and its subsequent migrations; and in the present case it is admitted by Mr Craufurd that there is a large infusion of Sanscrit in all the Polynesian tongues; that it is "a more essential, necessary, and copious portion of the insular languages than Arabic;" that it exists in "a state of as great purity as the articulation and alphabets of the archipelago would admit, nearly unmixed with any modern dialect of which it is a part, and apparently in a state of original purity;" and that it is "pure and abundant as each dialect of the same tongue is improved, and rare and corrupt as the language is common and popular."[2] Sanscrit words, according to those who are versed in both languages, abound in the court dialect of Java in the proportion of three to four, and seem to constitute its basis; in the Kaw, or learned language of the priests, they occur still more frequently, and in their original purity; they are also common in the written language, and are found, though not so generally, in the ordinary dialect of the people. The existence of Sanscrit to such an extent in the languages of Java and the other islands, does not, according to Mr Crauford, prove that these islands were peopled by emigrants from Hindustan. He acknowledges that the fact of the Sanscrit not being mixed in their languages with any living dialect of India, is somewhat puzzling, and not easily reconciled to his theory; but on farther consideration, he thinks this fact tends rather to explain the manner in which it was introduced, which he ascribes to a few Hindu missionaries or priests brought to those islands from a desire to propagate their religion. They would naturally, he supposes, use the Sanscrit in teaching the mysteries of their faith, which, being mixed with the common language of the country, would form the Kaw or learned language of the priests, and would thence be diffused in a corrupted state over the common dialect of the people. From the prevalence of Sanscrit to such an extent in the Polynesian dialects, as well as from the ancient monuments of Hindu idolatry which are foun everywhere in those islands, it seems highly probable that they must, at a very early period, have been the seat of a Hindu empire, which has disappeared in the lapse of ages, while the Hindu superstition has been supplanted by the Mahometan creed. Whether this empire was established by conquest in that early period, while the Sanscrit was yet

[1] Sir S. Raffles' *History of Java*, chap. ii.

[2] *History of the Indian Archipelago*, by John Crauford, F.R.S., vol. ii. chap. v.

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a living language, or whether the Hindus were the original settlers in these islands, and afterwards, from the intermixture of other races, lost the traces of their ancient lineage, are points which lie hid in the darkness of antiquity. It does not seem very credible, however, that a small number of Hindu missionaries should have had influence, as Mr Crauford supposes, to change the language of the people, and to substitute for the ancient religion of the country their own foreign superstitions. So great a change seems more probably to have been produced by foreign conquest, or by a large immigration of the Hindu people.

The Malays.

Of the various races which people the islands of Asia, the Malays appear to deserve particular notice. Sir W. Jones supposes them to be descended, since the time of Mahomet, from the Arabian traders and mariners who frequented the Asiatic archipelago. But by later and more accurate inquiries they are now ascertained to have been originally settled in Menangkabau, in the centre of the island of Sumatra, and to have ruled over the whole country, from which they sent out colonies to the other islands. The Malayan annals examined by Mr Marsden,[1] and other documents, satisfactorily prove that, so far from emigrating, as was generally supposed, from the peninsula of Malacca to the Asiatic islands, they were original settlers in Sumatra, from which they issued to invade and conquer the Malacca peninsula; and they had established a powerful empire prior to the Mahometan conquests. The Malays profess the Moslem creed, which was introduced about the end of the thirteenth century, and has made rapid progress among all those islanders. But their original religion was that of Brahma, blended with the antecedent rude idolatry of the country, such as is still seen among the Battas. The Malay adventurers who invaded the Malacca peninsula in the 12th century conquered the country; and the indigenous inhabitants, so far from being the stock from which the Malays have sprung, are an entirely different race, resembling more nearly the negroes of Africa. The Malayan empire, which extended all over Sumatra, is now dismembered, though its colonies have been found on the coasts of the Malacca peninsula, and throughout the islands as far east as the Moluccas.[2] The Malayan language is spoken without any mixture in the inland country of Sumatra; it is understood everywhere, and has extended over all the eastern islands. The Bugis in the island of Celebes are a well-known race in the eastern archipelago. During the flourishing era of the Malayan empire in Sumatra they had established that of Guah or Mengkasar in Celebes on the east: like the Malays, they sent forth numerous colonies; and at one period extended their conquests as far west as Acheen in Sumatra and Keddah in the Malayan peninsula; and in almost every part of the archipelago Malayan and Bugis settlers are to be found. In all those Asiatic islands there is, however, an indigenous race, who were settled there prior to the Malays or the Bugis; and these last appear to have been intruders, but at what period of the world cannot now be known. The native inhabitants of Sumatra, Java, and the other islands, differ from them in character, habits, and features. The Battas, in the interior of Sumatra, are a distinct people, with their own peculiar habits and language: they have been reproached by travellers for eating human flesh, of which Sir Stamford Raffles produces undeniable evidence. The natives of Java are a quiet, contented race, attached to the soil, and have not the roving, maritime, and piratical habits of the Malays.

Number of inhabitants.

With regard to the number of inhabitants in Asia, we have no data for any accurate estimate. The Asiatics possess no statistical knowledge; and, excepting surveys instituted by government for the purposes of taxation, no other political inquiries are ever set on foot by authority. The various accounts of the Chinese population differ to the extent of 100,000,000. Those regarding Persia, Hindustan, the Asiatic islands, &c. are little more to be depended on; and still less can we expect any accurate census of the roving population of Arabia or Tartary.

Character and manners of the Asiatic nations.

The character of the Asiatics is represented in a very unfavourable light by all travellers. Lieutenant Pottinger, who travelled in Hindustan, Persia, and other countries, asserts that moral turpitude may be said to pervade the population and society of every nation in Asia of which we have the slightest knowledge:[3] and this description is confirmed by other travellers, who describe the people to be dissolute in their morals, of cold and selfish dispositions, and withal cruel and treacherous; without any regard to truth, and indulging, without either restraint or shame, in the most scandalous crimes. Of all the nations in Asia the Persians are reckoned to be the most refined; and yet, according to Herbert, Chardin, and others, and more recently Fraser, Pottinger, and Sir J. Malcolm, they are stained with all the Asiatic vices of cruelty, meanness, lying, and the grossest licentiousness.[4] The Hindus do not rank higher than the Persians in the scale of morality; and among the Burmese and other eastern states the treatment of women, who are held to be an inferior class, and are sold into slavery by their husbands and parents, and the cruelties which they commit in war, besides other revolting customs, indicate a state of manners which, contrasted with those of Europe, may be justly considered barbarous.[5] Of the low state of morals among the Chinese we need seek no other evidence than the inhuman practice, which is known to prevail in all the populous cities, of exposing new-born children to perish on the streets. There is no truer mark of barbarism than an indifference to the sufferings of our fellow-creatures; as on the other hand it is only in a highly civilized community that man is trained to the exercise of social benevolence. The savage is always found to be cold, unsocial, and selfish: in the progress of society this selfish principle is corrected; man is impressed with the duties which he owes to his fellow-men, and is taught to know experimentally, that it is not in the selfish pursuit of his own good, but in the mutual interchange of benefits, that the greatest sum of individual happiness is to be found. If we examine the manners, institutions, and policy of different nations, it will be seen that mankind are humane and moral exactly as they are instructed; and that as the diffusion of knowledge leads to the practice of all the social virtues, ignorance as surely produces cruelty, selfishness, and vice. Thus, among the Persians and Turks cruelties are committed which would be repudiated by the more advanced civilization of Russia; and in illustration of the same principle we may here mention a circumstance which serves to place in an equally striking contrast the manners of the English and the Chinese. An

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[1] *History of Sumatra.*

[2] Sir S. Raffles' *History of Java*, chap. ii.

[3] See *Travels in Belochistan and Sinde.* "I hope," he adds in a note, "I shall not be stamped as a misanthrope on account of the sentiments I entertain of all Asiatics. I am convinced the farther our researches spread, and the more intimately we become acquainted with the East, we shall discover stronger, clearer proofs of the general application of the conclusion I have drawn. I should be happy to have any evidence to the contrary, but do not anticipate it."

[4] See Fraser's *Narrative of a Journey into Khorassan.*

[5] See Crauford's *Journal of an Embassy to the Court of Ava in the year* 1827.

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English vessel happened to be at anchor in the roads of Canton, when a Chinese boat was overset, and the crew precipitated into the water. The accident was observed by numbers of the Chinese, who beheld with the utmost indifference their countrymen struggling for their lives. But the officers and seamen of the English vessel instantly lowered their boats, and were seen, with all their usual zeal in the cause of humanity, striving to save the lives of those who were entire strangers to them. Now we cannot have a surer index to the station which each nation holds respectively in the scale of civilization, than the opposite conduct which they severally pursued in this case; and this insensibility to human distress is not peculiar to the Chinese; it seems to pervade the whole population of Asia; while in Europe we see everywhere proofs of active benevolence,—the most munificent establishments for the relief of misery; hospitals for the sick and infirm; houses of refuge for the aged, the blind, the destitute, and the insane; besides charitable associations of every description. For all the afflictions to which frail humanity is subject, the active sympathy of Europe supplies a remedy; and the spacious structures which, under the influence of this feeling, have been reared up in all the European towns, are at once the splendid monuments of humanity and of high civilization. In Asia the rich and the powerful associate, not to relieve, but to oppress the poor; and throughout its wide extent no asylum for distress, nor any charitable institutions, are to be seen. The miserable are left to their fate, which is generally to die unpitied, either of famine or disease. There is no part of Asia in which intelligence is widely diffused among the people; and hence, while they are to "vice industrious," they are to "nobler ends timorous and slothful." Yet in the exterior pomp and show of the Asiatics there is something specious and imposing; and the rich magnificence of their flowing robes, their gorgeous palaces, their splendid mosques and gilded temples, are calculated to raise ideas of high improvement, which a nearer inspection fails to realise; and, after all, what is there in this tinsel glare of oriental luxury that can be compared to the severe simplicity and solid refinements of Europe.

This degraded state of society seems to be the joint effect of tyranny and superstition. In Asia there is no government which wears even the semblance of freedom. In form, as well as in practice, they are purely despotic, the princes being tyrants, and the people slaves. Nor is the power of the prince controlled by the influence of manners, as in Europe, where the monarch, however absolute, seldom indulges in the licence of despotic sway, and where life and property are fully protected. The manners of Asia favour the exercise of unlimited power; and this vast continent is accordingly one scene of excess and misrule, where the mere will of the monarch is a warrant for the proscription and death of any individual, however powerful, and for the ruin of his family. The people, ruled according to those severe maxims of despotism, live in continual dread of violence and wrong; and they naturally resort, in self-defence, to fraud, falsehood, and treachery, which are the resources of weakness. Thus all sense of independence is at last extinguished; and under the iron rod of their political masters they degenerate into abject slaves, without honour, intelligence, or morality. Despotism in Asia assumes so severe a character, that it invades the security of private life, relaxes all social ties, and re-acting on the people with its pernicious influence, tends still farther to debase them, and to fit them for the endurance of its degrading yoke.

The prevailing superstitions of Asia have had their due share in corrupting the manners of the people. In Asiatic Turkey, in Arabia, Persia, and partly also in Hindustan and the Asiatic isles, the people have adopted the Mahometan faith; in Hindustan they have followed the religion of Brahma; and in Thibet, and farther eastward among the Burmese, in China, and the isles of Japan, the religion of Buddha or Foe is universally established, which, however corrupted in its various forms and idolatries, is still known to be derived from the Brahminical faith. Now all those different systems enjoin a variety of minute observances, and tedious pilgrimages and penances, a strict compliance with which constitutes the essence of religion. A pilgrimage to Mecca, for example, atones for all the iniquities of a Mahometan life; and the Hindus and others have their pilgrimages and penances for the expiation of guilt. A relaxation of morals is the consequence; and hence in those eastern countries a strict profession of religion is not inconsistent with the most scandalous crimes.

The sanction given to polygamy by all the systems of religion in the East has also tended to encourage licentiousness. Mahomet found it convenient to allow this indulgence to his followers; and the Hindus, the Burmese, the Chinese, and most of the other Asiatic nations, follow the same rule. In all Christian countries marriage is respected as a sacred and an honourable tie, equally binding on both parties; and experience proves, that where its obligations are duly fulfilled, it is calculated to produce all the happiness and virtue which can be attained by man in this sublunary state. In the intercourse of a European family the best affections of our nature are called forth. Here, as the poet expresses it,

Flows the smooth current of domestic joy;

and in those scenes the rising generation receive, from the example and tuition of parents, those just and early impressions, which are never erased. How different are the baneful consequences of polygamy, which, being contrary to the order of nature, must be upheld by tyranny, and which degrades the weaker sex, from being the free and equal companions of man, into the slaves of his pleasures. The domestic tyrants of the East rule with absolute power over all the inmates of the harem; any of whom, in a fit of rage or jealousy, they may consign to a cruel death, no eye witnessing the deed. The effect of polygamy in this manner is not merely to taint the morals of society, but the laws and policy of the state. It establishes a tyrant, not on the throne, which would be the lesser evil, but at the head of every family; and on his unruly passions the law imposes no restraint. Hence in Asia domestic comfort, so much prized in Europe, cannot be known. An Asiatic family is not the abode of purity and of domestic peace, but of licentiousness and strife; the husband and father the object of terror rather than affection; the women his abject slaves, leading a life of jealousy and malice, and often conspiring against each other by the most diabolical arts. The institution of polygamy, which in this manner converts one half of the community into tyrants and the other half into slaves, has proved, in every country in which it has been introduced, the bane of morality as well as of social peace. In Europe the purer influence of Christianity, consecrating the marriage union, and impressing on man a just consideration for the other sex, has raised them to the rank in society which properly belongs to them. It has released them for ever from the bondage of tyranny and vice; and under its mild and beneficent maxims the nations of Europe have attained to a degree of morality, refinement, and intelligence, which distinguishes them to their advantage above the most polished nations of antiquity, and presents a decided contrast to the licentiousness and misery of the East.

Manners of the pastoral tribes.

But if such be the state of society among the civilized inhabitants of Asia, what, it may be asked, is the condition

of its rude tribes? Among those semi-barbarians who have no fixed habitations, but who dwell in tents, migrating periodically with their flocks in quest of pasture, all crimes of violence, such as rapine, revenge, and murder, prevail without any restraint. The pastoral tribes of Asia retain all their Tartar habits of ferocity; robbery is their daily occupation, handed down from father to son; and they are perpetually engaged in predatory inroads, in which they carry off as their lawful prey all that they can seize—corn, cattle, goods, and men and women, who are sold for slaves. If any traveller were to venture within this region of violence, he would be robbed and murdered without mercy; and no merchandise can be transported from one place to another without a sufficient escort. The regular commerce of Asia is in consequence carried on in caravans, or large companies of merchants, who travel together for safety; and even these are not secure from the savage tribes, the remnants of the Tartar population, who inhabit the mountains and central plains, and who frequently emerge from their fastnesses in great force for the purposes of plunder. Such were the shepherds who, under Zinghis Khan and Tamerlane, issued forth in innumerable bands, subverting the great empires of the world, and extending their dominion from sea to sea. But various causes have concurred to circumscribe their power. Among these we may reckon the invention of fire-arms, which in war gives the entire ascendancy to civilized nations. Prior to this invention the weapons used were extremely simple, and could be easily fashioned by the rudest tribes. In archery, or in the use of the sling, the merest savages may excel; and for a close encounter the spear or the sword could be easily procured, and as effectually wielded by a barbarian as by any other arm. But the *matériel* of modern war is far more complicated and expensive, and cannot be procured without the aid of wealth, and the nicest mechanical art as well as science; so that it is justly observed by the historian of Rome, that in the present state of the military art, a nation must be civilized before it can conquer other nations. Since the invention of fire-arms the superiority of civilized over barbarous nations has been seen in every encounter which has taken place, and "the reign of independent barbarism has been contracted within a narrow span."

The extensive region of Tartary, which occupies the centre of Asia, has never been very distinctly defined; but it is surrounded on all sides by the civilized empires of Asia,—on the north by Asiatic Russia, and on the south by Persia, Hindustan, and China; and as the use of fire-arms has augmented the military strength of these different states, they have gradually extended their sway over the savage tribes on their frontiers. Russia, which was overrun by Tamerlane and other conquerors about the end of the 14th century, was, after about 200 years of obstinate and bloody wars, emancipated from the Tartar yoke; and it has ever since been making reprisals on its barbarous enemies, having reduced the tribes on its frontiers—the Kalmucs, the Bashkirs, the Kirghises, who inhabit the banks of the Volga and the country on the shores of the Caspian Sea, besides numerous other Tartar tribes on the Chinese frontier, near the sources of the Irtisch, the Obi, the Yenesei, and the Lena. Her wars with the Turks also, an Asiatic tribe, though of a different origin from the broad-featured race of Tartars, exemplify in a striking manner the warlike superiority of civilized nations. The contests of China with the barbarous hordes of Mongols, Kalkas, and Eluths, to the west and north-west of her territory, and with the Mantchoo Tartars, who inhabit the country to the north, bordering on the Pacific Ocean, have also terminated in their entire subjection. They have been successively subdued by the Chinese armies; and the missionary Gerbillon, giving an account of a great victory gained by the Chinese, ascribes it to the superiority of their artillery, which the barbarians had no means of opposing. Persia has been long a feeble power; and the Tartar tribes who range along her northern and eastern frontiers are still extremely powerful, and frequently molest the adjoining countries by their incursions. Independent Tartary may now therefore be comprised within the following boundaries, namely, the Altai Mountains on the north, which form the southern boundary of the Russian empire; the Caspian Sea on the west; Chinese Tartary on the east; and Persia and Hindustan on the south. These boundaries inclose a space of about 1200 miles in length, from the Altai Mountains to Persia; and 900 in breadth, from the Caspian Sea to Chinese Tartary. To this must be added the country between Hindustan and Persia, including Sinde at the mouth of the Indus; and westward the mountainous regions of Beluchistan, as well as Afghanistan. In the high district of Balk, which is within this space, and which is situated on the northern declivity of the Hindu Koh or Himalaya Mountains, and in Buckharia or Bokhara, on the fertile banks of the Oxus and the Jaxartes, where the towns of Bokhara, Samarcand, Khivah, Koukan, Khojund, and Murghelan, &c. some form of civil order is maintained by the independent princes of the country; but with these exceptions the Tartar manners still prevail throughout this extensive region. The towns are thinly scattered, and the pastoral hordes range over the face of the land in all the licence of savage freedom. These consist, not of the Tartars who possessed the country in the time of Tamerlane, but of the Usbecks, a Turkoman tribe, who appear to have descended, with the whole mass of their people, from the inhospitable countries in the north, to the fine plains of the Oxus and the Jaxartes, and to have expelled the Tartars, whose place they now occupy. The Turkoman tribes, who inhabit the Elburz Mountains to the south of the Caspian, and the deserts of Kharasm, which extend eastward from this interior sea about 600 miles, are described by Fraser, in his instructive work on Persia, as singularly fierce, cruel, and blood-thirsty in their habits. They pour down from their deserts in great force on the cultivated districts, plundering villages and caravans with every circumstance of atrocious outrage, murdering on the spot the old, the feeble, and the helpless, and carrying into slavery those who are fit for labour, and thus depopulating extensive tracts that were before fertile and well inhabited. On the east of Persia the same ravages are committed by other tribes, who dispose of their captives to slave merchants, by whom they are carried to the markets of Bokhara and Khivah. On the south the wild inhabitants of Beluchistan, so well described by Lieutenant Pottinger, one of the most judicious and enterprising travellers of modern times, plunder and murder their prisoners, or carry them for sale to some of the great slave-markets in the East. Numerous tribes of shepherds feed their flocks on the banks of the Oxus and the Jaxartes; and they are found scattered over all the northern and eastern countries of Central Asia, as far as the boundaries of Russia and China. But in the present improved state of the military art they are no longer formidable, and they waste their force in casual inroads, which are easily repelled.

Progress of discovery in Asia.

From the earliest ages the countries of Western Asia, namely, Asia Minor, the valley of the Euphrates and Tigris, and Persia, were familiarly known to Europeans; but of the northern plains inhabited by the Scythian tribes, and of the rich and improved countries of Hindustan and China in the east, they were only informed by vague and inaccurate reports, which were slowly corrected by the progress of commerce or of conquest. Of the ancient

expedition of Semiramis into India we know nothing more than that her armies were forced to retreat with loss. But the subsequent invasion and conquests of Darius extended the knowledge of the Europeans to the modern provinces of Lahore and Moultan, commonly called the Punjaub, or the country watered by the five head branches of the Indus. Herodotus describes the climate of the country as intensely hot; the inhabitants in some points as little better than barbarians; and with a small grain of truth he mixes the strangest and most absurd fables. He mentions the populousness and wealth of the country, and the staple produce of cotton or wool growing on trees; the story of the white ants turning up the earth and digging up gold, which has been copied by succeeding writers; and, finally, the region of the five rivers as bounded by a barren plain, which must no doubt be the sandy desert that lies between the valley of the Indus and the Ganges. The Scythians or Tartars who wandered over the northern and eastern plains of Asia were only known by their irruptions into Europe. The two tribes of the Massagetæ and the Sacæ, the former inhabiting the desert plains to the east of the Aral and north of the Jaxartes, and the latter the country to the north-west of India, are mentioned by Herodotus and other ancient writers; and their description is merely a detail of pastoral manners. The expedition of Alexander into India was a great step in the progress of Asiatic geography. This warlike prince was intent not merely on conquest, but on the diffusion of arts, commerce, and science; and, like some modern conquerors, his army was accompanied by a body of men of science, who were instructed to measure each day the distance traversed, to make an accurate table of the various routes, and to observe and describe the countries through which they passed. Science thus followed in the train of arms; and it was by a European army that the remote regions of the East were first explored. Alexander pursuing his victorious march through Asia Minor, passed the limits of European discovery, and entered the eastern country of Bactriana in pursuit of the Persian army. Having passed the Paropamisan range of the Himalaya Mountains, crossed the Oxus, and taken Maracanda, the modern Samarcand, he advanced northward to the Jaxartes, where he pursued the Scythian host into the northern deserts to the eastward of the Aral. Retracing his steps, he again crossed the Paropamisan Mountains, and advancing eastward among hostile tribes, through the modern country of Cabul or Afghanistan, to the south of the Hindu Koh range, he crossed the Indus near the mountains, and having defeated the Indian army of Porus, he obtained the command of the country watered by the five tributary streams of the Indus, where his course was arrested by the murmurs of his troops, who refused to follow him across the desert to the Ganges. Still intent on discovery as well as on conquest, he fitted out a large fleet, and sailing down the Indus to its mouth, in the Indian Ocean, he instructed his admiral, Nearchus, to return to Persia by sea, while he took his course through the modern country of Mekran, and was nearly lost with his whole army in its sandy deserts. Nearchus directed his course along the shores of Asia, and triumphing over the perils of unknown seas, arrived safely in the Persian Gulf, which he ascended to the mouth of the Tigris. This is the first great voyage of discovery of which we have any authentic account; and considering the age of the world in which it was accomplished, it must be viewed as a singular display of courage and of nautical skill. Alexander was not equally successful in tracing the connection of the Red Sea with the Indian Ocean, which remained unknown until the reign of the Ptolemies in Egypt.

Seleucus, the successor of Alexander, carried his arms into India for the purpose of completing its conquest; but he does not appear to have reached the valley of the Ganges. He sent, however, to the court of Sandracottus, an Indian prince who reigned over all the countries from Delhi to the mouth of the Ganges, his ambassador Megasthenes, who acquired the most important and clear information respecting those unknown regions. He visited the celebrated city of Palibothra, the site of which has so much perplexed modern geographers; and, with some admixture of fable, he accurately describes the countries on the Ganges, and their productions; the amazing size of the rivers; the most remarkable animals which he saw, among others the Bengal tiger; and the manners of the people, and their division into castes, with other singular customs.

During the reign of the Ptolemies in Egypt the geography of Asia was still farther illustrated, not by conquest, but by commerce. Alexandria was at that time the great emporium of the eastern trade; and India was explored in its most remote parts, for the precious commodities which it was supposed to produce. The Egyptian mariners entering the Indian Ocean from the Red Sea, and coasting along the Arabian shore, stretched across the Persian Gulf by the help of the south-west monsoon, to the mouth of the Indus, whence they sailed southward along the Malabar coast, and doubling Cape Comorin, extended their voyage on the coast of Coromandel as far as the modern city of Masulipatam.

In the age of Ptolemy the geographer, which was a century later, the knowledge of the Europeans had extended eastward beyond the Ganges to the Burman empire and the Gulf of Siam, though it does not appear that the navigators of antiquity ever reached the Chinese coast. The commerce of India was carried on by land as well as by sea; and regular caravans commenced their route from Byzantium eastward through Asia Minor and Persia, passing through the modern cities of Hamadan and Herat; and journeying northward, and crossing the Oxus and the modern country of Bokhara, they passed the great branch of the Himalaya Mountains which runs northward from the main range under the modern appellation of Bolor Dagh; and descending into the lower plains of Little Tibet, they assembled in great numbers, and, after halting for some time, took their journey to the capital of Serica or China, which occupied a period of seven months. The description given of the Seres as a frugal and mercantile people, averse to all intercourse with strangers, and carrying on their trade at a single station on the frontier, answers entirely to the modern character of the Chinese. The commerce, which during the flourishing era of Rome was carried on between Europe and the eastern parts of Asia, was interrupted by the inroads of the barbarous nations who assailed, and in the end overthrew, the Roman empire; and all knowledge of Asia was for a time lost. It was not till the 6th or 7th century, during the reign of the caliphs at Bagdad, that the Arabian geographers acquired a knowledge of those countries. During this period the country to the west of the Bolor Dagh Mountains, which stretch northward nearly to the frontier of Siberia, consisting of extensive plains, watered by the Oxus and the Jaxartes, was well known to them; and they were imperfectly acquainted with the southern plains of Asia inhabited by the Tartars, though they were as usual the subject of fables. The eastern countries of Hindustan, the beautiful region of Cashmere, the great Asiatic plains, and China, with the island of Sumatra and others, were known to the Arabian geographers, though they seem to have had no correct knowledge of the Asiatic shores. Their accurate description of Chinese manners leaves no doubt of their having reach-

ed that country. The invasion of the Holy Land by the crusaders tended, among its other consequences, to introduce into Europe a knowledge of those countries in Asia which were famed for wealth and the remains of ancient refinement; and from the camps of the crusading kings, as well as from the pope, some remarkable embassies were sent to the Tartar sovereigns, the descendants of the conqueror Zinghis, the site of whose capital of Karrakorum is now the subject of dispute, though it is generally agreed that it must have been situated far east, in the wilds of Tartary. The object of the embassies dispatched by the pope to the Tartar camp was to divert the storm of barbarian invasion from Europe. The ambassadors were friars, who were carried to the head-quarters of the Tartars, in the eastern wilds of Asia, through countries which had never been explored by any European. Rubruquis, a friar, who was sent ambassador by St Louis to the Tartars, has given a lively and circumstantial account of his adventures. He reached the Tartar capital of Karrakorum after a fatiguing and dangerous journey of more than two months, having traversed a vast tract of unknown country, and brought to the knowledge of the Europeans the immense plains and high lands of Central Asia, Eastern Tartary or the country of the Mongols, Thibet, and Cathay or China, and the eastern shores of the continent. All those countries were afterwards visited by the celebrated Venetian traveller Marco Polo, who, being dazzled by the splendid accounts diffused through Europe of the wealth and luxury of Asia, was inflamed with the desire of exploring those distant countries. He accordingly proceeded through Asia Minor, Persia, the high country of Balk, visited the cities of Cashgar and Yarkund, and skirting the great desert of Shamo or Cobi, he reached the Tartar capital of Karrakorum, and finally entered the Chinese empire, of which his account is circumstantial and correct, and of which some of the magnificent cities, though they have fallen from their ancient importance, are still recognised in his accurate description. He returned to Venice by sea after an absence of twenty-four years, having obtained accounts of the eastern islands of Java, Sumatra, Ceylon, and of Ormus in the Persian Gulf, at that time the great and splendid emporium of the Indian trade. The discovery, in 1498, of the passage to India by the Cape of Good Hope, opened the Indian seas to the European fleets; and shortly after this great event, the southern, and partly also the eastern shores of Asia, were completely explored, as well as that great archipelago which extends from the Malacca peninsula to New Holland. In the interior of the continent the progress of discovery was much slower, and only kept pace with the gradual extension of the Russian dominion over the barbarous tribes in Northern Asia. The Tartars under Tamerlane in 1382 had invaded the east of Europe, had taken Moscow, and overrun all the countries on the Volga and the Dnieper. The rise of the northern empire was for more than two centuries obstructed by the inroads of the barbarians; and it was only after long and obstinate struggles that they yielded to the superiority of the Russian arms. About the middle of the 16th century Russia had extended her conquests to the Obi, and her empire was enlarged northward and eastward, until it reached the frontiers of China and the Pacific Ocean. The general form of the continent, which was exhibited in the maps from mere conjecture, was in this manner laid open to Europeans; and in the course of the last century the eastern and northern shores were surveyed; also Kamtschatka, the Kurile Islands, and Jesso. The islands of Japan had been previously discovered by navigators. The relative limits of the Asiatic and American continents were traced by Behring, Tschirikoff, and other navigators, who also discovered the Aleutian or Fox Islands; and finally by Captain Cook, who advancing into Behring's Straits as far as the parallel of 70° 44′, ascertained the near approach and true bearing of the two continents.

The interior countries of Asia near the Caspian and Aral Seas have been visited by Russian travellers, who have corrected some errors of long standing in Asiatic geography. Lake Aral was either unknown to the ancients, or they confounded it with the Caspian Sea, of which they supposed it to form a part, and to be the receptacle of the great river Oxus. After the fact of two separate seas was fully known, the Oxus was still supposed to terminate in the Caspian; and its course was laid down accordingly in all the most approved charts. The Russians, having visited those countries, ascertained by actual observation that the Oxus, as well as the Jaxartes, terminates in the Sea of Aral. There seems, however, an ancient channel by which at least one portion of the waters of the Oxus at one time may have found their way into the Caspian, as mentioned by ancient authors.—Humboldt, *Asie Centrale*, ii. 296.

Eastern Asia, namely, the Chinese empire, with the source and termination of all its great rivers; the northern country of the Tartars; the course of the great river Amour; with the high lands of Central Asia, namely Mongolia, the original seat of the Mongols, were in the course of the sixteenth and seventeenth centuries explored by the Romish missionaries, as well as by mercantile travellers. In 1624 Antonio d'Andrada, a Jesuit, travelled from the coast of the Great Mogul to China. He passed through the country of Serinagur, and ascending the great Himalaya range, he and his companions endured such incredible hardships that he was forced to return. He afterwards crossed these mountains along with a caravan, and was among the earliest travellers who reached the country of Tibet, which he describes, and also the manners and religion of the people. In 1603 the missionary Goez set out from Lahore, where he resided at the Mogul court on his way to China. He travelled westward, and crossing the Indus, passed through the countries of Kabul or Afghanistan, Cashgar to the N., and the country on the banks of the Oxus; and crossing a ridge of the Himalaya Mountains, he arrived at Yarkund. From this place he journeyed with a caravan across the central country of Mongolia to China. These missionaries were received into high favour by the Chinese emperors, who valued them on account of their science, and gave them access to the public archives, which contained all the Chinese surveys of the empire and of the adjacent countries. By the help of these they exhibited with accuracy the interior geography of Tibet, and also of that extensive country beyond the Ganges which now forms the Burman empire, and which is watered by the great rivers that take their rise in the central mountains and run southward,—the Irawaddy into the Indian Ocean, the Setang into the Gulf of Martaban, of which it forms the estuary, the Saluen into the same gulf, the Menam into the Gulf of Siam, and the Menam Kong or the Mekong into the Chinese Sea.[1] These missionaries prosecuted with equal activity and zeal their inquiries into the interior geography of China;[2] they traced the great

[1] See Crauford's *Journal of an Embassy to the Courts of Siam and Cochin-China*. Geographers are not agreed on the respective appellations of these rivers: in this we have been guided by Mr Crauford.

[2] For a more detailed account of these missionary travels the reader is referred to Hakluyt's *Collection of Voyages*; Purchas' *Pilgrims*; *Histoire Générale des Voyages*, Paris, 1749; and to the *Historical Account of Discoveries and Travels in Asia*, by H. Murray, who has given an equally learned, judicious, and comprehensive abstract of all the existing information on the subject of Asiatic geography.

rivers the Hoangho or Yellow River, and the Yank-tse-Kiang or Blue River, to their termination as well as to their source, which they found to be in the depths of the central mountains, and not in the imaginary lake of Cayamay, as had been generally believed. Grueber, who set out on his travels to the East in 1656, traversed the whole country of China, partly by land and partly by water; and his route to Europe was through the Tartar deserts to Lassa, a town in Tibet, and thence through the mountainous country of Nepaul to Battana on the Ganges, Benares, and finally to Agra, which he reached after a journey of more than twelve months. Other journeys equally enterprising were also undertaken by the missionaries. Desideri set out in 1714 from Delhi, and travelled across the Himalaya Mountains through Cashmere into Tibet; and, at a later period, Horace de la Penna, with a body of twelve missionaries, resided in the same country for a number of years. The missionary Gerbillon, who was in great favour at the Chinese court, travelled in 1688 through the Tartar deserts, with a Chinese embassy, to the banks of the Selingha, there to settle with the Russians the respective limits of the two empires; and having been also in the practice of following the emperor in his hunting expeditions into Tartary, he contributed with other travellers to illustrate the geography of these countries and the manners of the people.

The great extension of the British conquests in Northern India has laid open to Europeans all that portion of Asia which lies on the southern declivity of the Himalaya Mountains, which is interesting not only from its natural grandeur, but also as it contains the sources of the Indus, the Ganges, and the Brahmapootra. The Europeans were indebted for all the knowledge which they possessed of those countries to the Chinese missionaries, who represented the Ganges to rise on the north of the Himalaya chain, from two small streams which pass the town of Ladak. They fixed the source of the Indus in the Bolor Mountains, one of the cross ridges which run N. and S. from the main Himalaya ridge. The British in India, with all their characteristic ardour in the cause of science, have corrected those errors of the Chinese geographers, having ascertained the source of the Ganges to be not on the N., but on the southern side of the Himalaya Mountains. The extent and bearing, and the vast elevation, of many of the highest peaks of this northern barrier of Hindustan, have also been fixed by the accurate observations of Lieutenant Webb and other officers. From the embassy of Elphinstone into Afghanistan we have received more full details of that country; and the course westward of the great Himalaya chain has been accurately traced, as well as the upper course of the Indus, through the source of that river is still imperfectly known. The missions of Turner into Bootan, of Kirkpatrick and Buchanan into Nepaul, and the embassy of Major Symes and Dr Buchanan to the court of Ava, and of Mr Crauford, who resided in the character of ambassador at that court, and whose works have thrown great light on the commerce and manners of Asia, have contributed materially to illustrate the geography of those countries. Of the vast regions of Tartary to the W. of China, and under its dominion, we know little except from the earlier travellers and missionaries, and from the accounts published of the journeys of the Russian embassies through these countries. The travels of Huc, Gabet, and Puch, have made some additions to our knowledge of Tartary and Tibet; and the hitherto proverbial jealousy of the Chinese authorities in regard to the intrusion of foreigners into their western dominions, may perhaps now be expected to give way to a more tolerant policy.

Asiatic commerce.

Asia, notwithstanding the wars by which it has been desolated, was from an early period the seat of commerce and of wealth. The eastern countries of Hindustan and China appear to have preceded Europe in civilization and industry, and, independent of that diversity of natural productions which is the foundation of trade, they had cultivated many arts and manufactures which were unknown in the Western World. Asia accordingly abounded in many precious commodities which could not be produced by the ruder industry of Europe. Thus China had its silk and porcelain; Hindustan its muslins, cotton, precious stones, and aromatics of all sorts; costus, bdellium, spikenard, ivory, tortoise-shell, pepper, &c. These were in general demand throughout Europe, where they could not be produced; and they were procured in exchange chiefly for bullion, which then, as in later times, was the great article of export to India; also for woollen cloths, wine, brass, lead and tin, glass, coral, female slaves, &c., all which commodities met with a ready sale in the markets of Hindustan. The staple commodity of China was silk; and the mode of producing this esteemed luxury being unknown in Europe, it was brought in large quantities, either by the caravans or by the annual fleets, to Alexandria, at that time the great commercial mart of the East, and was thence sent to supply the demand at Rome, where it sold at one time for its weight in gold; but, owing to the high profit, caravans began to travel so regularly to China, that the supply increased with the demand, and the price was reduced. Between the sixth and the seventh centuries Eastern Asia was robbed of this precious monopoly by the art of two Persian monks, who contrived, in a hollow cane, to transport the eggs of the silk-worm from China to Europe, where they were hatched by means of heat, and the race quickly propagated; and one great link of commerce between China and Europe was in this manner broken. The trade of Asia was interrupted by the irruption of the barbarians, who invaded and finally subverted the Roman empire; but the moment the storm was past, commerce resumed its quiet course. Constantinople, the eastern capital of the empire, was still the centre of luxury and trade; as were also such parts of the Roman territory as had not been swept by barbarian invasion; and with those places the caravans still traded, shaping their course as they best could to avoid the distractions of the interior. Farther to the east the khalifs who reigned at Baghdad encouraged science, commerce, and the arts; and the extensive country through which the Oxus and the Jaxartes flowed was the seat of a flourishing commerce and of many opulent cities. Besides Bokhara, still a great city, Balk, Samarcand, Cosh, and others in the valley of the Oxus and the Jaxartes, numerous splendid cities are enumerated which are scarcely known to Europeans. To the east of the great range of mountains which takes a direction from the main Himalaya ridge, the country of Cashgar contained Cashgar its capital, and Khoten, which were both large, populous, and wealthy. Those countries served as the connecting link between India and Europe, and the resting-place of the caravans, which there collected in great force, and prepared for their journey to China across the great eastern desert, or for a more southerly course through the country of Tibet. The armies of Zinghis Khan in the thirteenth, and of Tamerlane in the beginning of the fifteenth century, laid waste this highly-cultivated and flourishing region. But those conquerors were not the enemies of commerce, and the surplus produce of India still reached Europe, though by a route rendered more difficult and dangerous from the desolation of the intervening countries. But the effect produced on the trade of Asia in the East by the encroachments of barbarism, and by the disorders in the interior, was more than counterbalanced by the growing civilization of Europe. About the beginning of the fourteenth century, the darkness which had so long covered the western world began to dispel, and the Italian cities of Venice, Genoa, and others, had already made advances in letters, science, and commerce. The costly articles of Asia, her rich stuffs and precious aromatics, were now required to answer the grow-

Asia.

ing demands of luxury and wealth; and the produce of India, imported into Alexandria through the Red Sea, was thence brought into Italy by the nobles of Venice and Genoa, who were all engaged in trade, and was diffused in smaller quantities all over Europe. The Italian states were enriched by this lucrative traffic, which only ceased with the discovery of the maritime route to India by the Cape of Good Hope. From this period the trade between Asia and Europe took a different direction. The commodities of India and China were transported to Europe directly by sea; and neither Alexandria nor the other ports of the Red Sea or of Italy were any longer the depositories of the Eastern trade. The Portuguese, always distinguished by their ardour for maritime discovery, were the first adventurers in the Asiatic seas. In the course of the sixteenth century the English and Dutch appeared as their competitors; and with the growing wealth of those countries the trade to the East rapidly increased. The commerce of Asia may therefore be distinguished into the following branches:—*1st*, The inland trade of China, Hindustan, Burmah, &c., with Turkey, the eastern countries of Europe, and with the intervening countries of Persia, Balk, Bokhara, and the regions of the Oxus; also, by a different route, the trade with Russia and the N. of Asia. *2dly*, The maritime trade, including the coasting trade and the trade to the Eastern Archipelago, and the great trade to Europe and America, in which, from the progress of wealth and luxury, there is a great consumption of Asiatic produce.

Inland commerce.

The inland trade of Asia is carried on by caravans, or large bodies of merchants, who travel together for the sake of security through those parts of the country which are disturbed by predatory tribes. It is only from the southern countries of Asia, such as Hindustan, China, the Burmese countries, Tibet, and the western countries of Persia, Afghanistan, Bokhara, and the regions of the Oxus and the Jaxartes, that Europe can derive any supply of valuable commodities; and all this trade, from whatever quarter it comes, must flow in its progress to Europe through the countries that lie between the Persian Gulf and the Caspian Sea; as the caravans could not, without inconvenience and danger from wandering tribes, pass to the north of this sea or the Sea of Aral; and accordingly, though an annual caravan is sent from Astracan to Khyvah and the countries on the Oxus, the chief trade with Russia is by sea to the port of Mangalshuck, and thence to Khyvah and Bokhara. The Russians have also begun to trade with Persia from the Caucasian province of Georgia, of which Tiflis, the capital, has, from a wretched collection of wooden huts, been rapidly improved, under the protecting influence of a European government, into a respectable and wealthy town, the future emporium, as may be anticipated, of this growing trade. The caravans from Constantinople and Syria proceed through Asia Minor and the northern or southern provinces of Persia, according as their ulterior route is through Afghanistan and the Punjaub into Hindustan, or to Tibet and China, or the more northern districts of Balk, Bokhara, and the country of the Oxus and the Jaxartes. Bokhara though reduced to desolation by Zinghis Khan, is still one of the largest towns of the East, its population being estimated by Burnes at 160,000. It is also a great commercial mart; and the caravans which come from the west, passing along the southern shore of the Caspian Sea through the Persian province of Astrabad, a most luxuriant and fertile country, arrive successively at Balfroosh, Ashruff, Astrabad, Mushed, Serrukhs, Merve, formerly the capital of the Seljook sovereigns, but now surrounded by deserts, and at Bokhara. From this great centre of commerce they proceed north-eastward about 400 or 500 miles to Khojend and Kokaun, the former a large city, said to contain 30,000 houses; and crossing the Bolor range of the Himalaya Mountains, they arrive in the Mahometan states of Kashgar and Yarkund, 600 miles E. of Kokaun, passing some towns on the way, of which Ush is the most important, being a trading and populous town. Those two latter states lie within the precincts of the Chinese authority, where the most exact order is enforced; and they are fertile, rich, and well cultivated. The town of Cashgar is said to contain 20,000 houses, and to be thronged with strangers from all parts of Asia. Yarkund is also wealthy and populous. So strict a police is maintained by the Chinese authority, that, according to the information given to Fraser,[1] a single traveller may traverse the whole territory as safely as a large caravan. From Kashgar there is a constant intercourse through Chinese Tartary, along the edge of the great central desert, with China, though we know little of the intervening countries beyond what we learn from the accounts of the early missionaries. Besides this eastern trade, and the trade westward along the southern shore of the Caspian, two caravans, consisting of 4000 or 5000 camels each, proceed to Astracan by Khyvah, round the northern shore of the Caspian Sea. The imports from Russia into Bokhara are iron, steel, copper, brass, quicksilver, vermilion, coral, hardware, plated goods, gold and silver embroidery, copper wire; furs, the broad cloths and cotton manufactured goods of Britain, Germany, and France; refined sugar, cochineal, paper, and a variety of rich goods, which, from this great commercial depot, are diffused far and wide over Central Asia. Russia receives in exchange black lamb-skins, certain manufactures of cotton and silk imported from Persia, antique gems and coins, lapis lazuli, rubies, and turquoises, which are received from the southern country of Buducksha, where there are famous mines of these precious stones. From Cashgar, Yarkund, and the side of China, Bokhara receives large quantities of tea, the great modern staple of the China trade, porcelain and China ware, and the various manufactures of China; and in return sends turquoises, coral, sheep, lamb, and fox skins, and furs, &c. From Persia shawls are imported, and woollen goods from Kerman; silk stuffs from the cities of Yezd and Ispahan; gold and silver embroidery, copper ware, loaf, candy, and raw sugar; Hamadan leather; and turquoises, of which there are mines in Persia; and, in return, black sheep and lamb skins are sent, which are in great request, to be manufactured into black caps; camblet made of camel's hair, coarse coloured silk handkerchiefs, lapis lazuli, indigo from India, cochineal, tobacco, chintzes from Masulipatam, and cotton manufactures. Slaves form a staple article in the commerce of Bokhara, and also of Khyvah. These are made prisoners by the disorderly tribes of Asia, the Koords, Turkomans, &c., in the course of the wars in which they are constantly engaged; and they are carried to the great slave markets of Bokhara and Khyvah, where they are exposed for sale like cattle. The balance of trade is always in favour of Bokhara. Money is consequently in great plenty and cannot be imported with a profit into this trading city. The Russian caravans, as they journey round the N. shore of the Caspian Sea, are frequently attacked by the Kirgeesh and Cossack tribes, and prisoners are carried off and sold into slavery. Fraser was assured that the number of Persian slaves in Khyvah and its dependencies exceeded the male population of these countries, and amounted to 150,000; and that, according to inquiries set on foot by the Empress Catherine, there were in Bokhara no less than 60,000 Russian slaves.

The commerce of the west with the southern countries of Asia, namely, Kabul or Afghanistan, Cashmere, and India, passes through Persia by a different and more southerly route, namely, by Cashan, Yezd, which is the seat of rich silk manufactures, a great entrepôt of commerce, and a conve-

[1] *Narrative of a Journey into Khorassan*, Appendix.

nient resting-place for all the caravans, both from the East and other quarters; through Furrah and Herat, on the frontiers of Persia, famed for its rich manufactures of silk stuffs, a great channel of communication between the East and the West, and also an entrepôt of all the richest productions from Kabul, Cashmere, and India on the one side, and from Bokhara, Persia, Arabia, Turkey, and even Europe on the other. From Herat the route continues through Furrah and across the river Helmund and the ranges of the Paropamisan Mountains, to Candahar, a journey of about 800 miles; thence to Kabul, Peshawur, and the countries on the Indus, and across extensive sandy deserts to the rich valley of the Ganges, whence by this river, there is an easy access to Bengal and to Central India. There are various other routes by which the commerce of Asia, concentrated within the comparatively narrow boundaries of the Caspian Sea and the Persian Gulf, diverges in its progress eastward to the N., as well as to the S. From Bokhara there is a mountainous route into Little Tibet, and thence through Tibet into China; besides other more sequestered and difficult roads, through glens and mountains, where the only mode of transport is on the backs of asses and mules.

Persia, from its central situation between the East and the West, is not only a great entrepôt of Asiatic trade, but, though on the whole rather a poor country, it still contributes some valuable productions to the commerce of the East. It has long been famed for its abundant produce of raw silk, of cotton, and of wool—that of the province of Kerman especially being so valuable for shawls that it rivals in some respects that of Cashmere; of fruits, turquoises, tobacco, grain, &c. Almost all the principal towns of Persia, such as Kashan, Ispahan, Yezd, Tabreez, Kerman, Herat, &c., excel in the manufacture of silks, cottons, woollens, fine carpets, &c.; Kerman also in the manufacture of shawls; and others in that of cutlery, arms, &c. These are its chief exports to other countries, in exchange for their manufactures or produce. To India Persia sends raw silk, carpets, Kerman shawls, dried fruits, tobacco, horses—in which there is a considerable traffic, swords, &c., and specie to make up the deficient balance. The imports from India are cotton goods, as chintzes, sent from Masulipatam by sea to Bushire, whence they reach the interior of Persia, and are thence carried eastward into Kabul and the countries on the Indus; the same article from Moultan, Lucknow, Delhi, &c.; some muslins, indigo, spices, sugar, and sugar-candy, in large quantities; gold and silver stuffs and brocades from Benares; precious stones, Cashmere shawls, iron, lead, copper, &c. Many of these articles, namely, Cashmere shawls, spices, indigo, muslins, &c., are carried through Asia Minor by a long land carriage to their final destination in European Turkey, and are found, along with the lamb-skins of the no less distant Bokhara, in the bazaars of Baghdad and Constantinople.[1] To those countries Persia exports also every article of her own rude and manufactured produce; coarse fabrics, both of silk and cotton, for the consumption of Asia Minor; and many heavy articles, such as grain, rice, tobacco, salt, coffee, cotton, &c.; besides fine silks, brocades, and prints, which are exchanged in Turkey for European goods brought through the countries of the Levant, namely, broad and narrow cloths, cassimeres, cotton goods, chintzes, muslins, veils, silks, satins, French brocades and embroidered goods, imitation shawls, cutlery of all sorts, glass, &c., and a considerable quantity of gold and silver bullion. Persia imports coffee and pearls from Arabia, in exchange for wheat, dried fruits, and cloaks. The mountainous country of Afghanistan, on the southern declivity of the Himalaya ridge, and the country on the head streams of the Indus, export to India horses and ponies bred in Tartary, fur, shawls, Moultan chintz, madder, assafœtida, tobacco, and dried and other fruits, such as almonds and pistachio nuts. The imports from India are coarse cotton cloths, worn by the common people of this country, and also in Tartary; muslins and other fine manufactures, silken cloth and brocade, indigo in great quantities, ivory, chalk, bamboos, wax, tin, sandal-wood, almost all the sugar which is used in the country, and spices from the Malabar coast, through Kurrachee and other parts of Sinde, and thence to Kabul and Candahar. The Indian cloths, shawls, chintzes, and also the indigo, are exported to Bokhara, from which are imported the broad cloths, cutlery, and hardware of Europe, received from the Russians, and finally consumed in Kabul and the countries of the Indus, loaded with the expenses of a land journey across nearly half the globe.

In the E. of Asia, China has from the earliest times been the seat of wealth and of an extensive trade. The Chinese have been always noted for their industrious habits, and the country has from time immemorial abounded in the most valuable produce and manufactures. These were sent westward in the caravans to Asia Minor and into Europe, or they were transported by sea to India, and carried thence by the European fleets to the Red Sea. The same commerce is still continued, and China exports its produce of woollens, silk, and satin; tea in small boxes of thin lead; china, porcelain, raw silk, cochineal, crystal, gold dust, golden ingots, and silver with the Chinese stamp. These are sent through Chinese Tartary into the countries on the Oxus, and also to Cashmere, Kabul, and the countries situated on the southern declivity of the Himalaya Mountains. Regular caravans of horses and ponies, no other animal being fit to travel through those mountainous districts, set out from Cashmere, and from Peshawur, the capital of the Afghan country of Kabul, and a considerable commercial resort, to make their way through Chinese Tartary with goods imported from India and Persia. China carries on also an interior trade to a considerable extent with Russia by the frontier town of Maimatchin, in which European goods and furs are received in exchange for tea, silk, and other articles of Chinese produce and manufacture.

Maritime commerce

In addition to her internal trade, Asia maintains an extensive intercourse by sea with Europe, America, and with Egypt and all the countries on the Mediterranean. A great trade is also carried on from Hindustan and China to the Asiatic Archipelago, and the trade of the Asiatic islands with each other is of great importance. It appears that those islands were at a very early period the seat of commerce; and the learned researches of Europeans have brought to light, in some of them, the monuments of ancient civilization. Sumatra was the seat of the Malay empire, Java of a Hindu state; and the Celebes were inhabited by the Bugis, a race of expert navigators and merchants. The productions of these islands, and of the Moluccas and Borneo, namely, spices, aromatics, and gold, entered into the commerce of the ancient world, and were imported into Rome through Egypt. In later times, about the ninth century, the Asiatic Archipelago was visited by the Arabs and the Chinese, while the adventurous Malays frequented the coasts of Asia, and even of Africa, and particularly the African island of Madagascar. When these islands were visited by Europeans, about the fifteenth century, Malacca, Acheen, and Bantam were the great marts of the Eastern Archipelago, where the rich produce of Sumatra, Borneo, and the Moluccas, conveyed in the small trading craft of the country, was exchanged for that of India and China.

[1] Elphinstone's *Cabul*; Kinneir's *Geographical Memoir of Persia*; Fraser's *Travels in the Persian Provinces around the Caspian Sea*, Appendix, p. 364.

The Portuguese fixed on Goa, on the Malabar coast, as the capital of their Eastern settlements; and they afterwards selected Malacca as a central station for protecting and extending their intercourse with the neighbouring nations. The Dutch chose Bantam, and afterwards Batavia, situated midway between Hindustan and China, as the centre of their commercial settlements. The situation was most advantageous, and the port was soon frequented by vessels from China and Japan, Tunkin, Malacca, Cochin China, and the island of Celebes. But the great and flourishing trade of Java was crushed under the colonial monopoly of the Dutch, and under what Sir Stamford Raffles terms "the short-sighted tyranny of a mercantile administration." The conquest of Java by the British in 1812 put an end to this thraldom, and the great trade of the Asiatic Archipelago began to centre in Batavia, which was fast rising into a great commercial emporium; all the articles which were the exclusive produce of the Eastern islands being collected at its principal ports for re-exportation to India, China, and Europe. Since Java was restored to the Dutch, the free port of Singapore, established by the British, is the centre of a great trade, and is frequented by the Chinese in their junks, and by all the other navigators of those seas with the produce of their respective islands. The Chinese take back with them the nests of a certain species of bird, which are esteemed a great luxury at their tables, and sell, it is said, for their weight in silver; biche-de-mer or tripang, a dried sea-slug, also used in Chinese dishes; Malayan camphor, the exclusive produce of Sumatra and Borneo; the tin of Banca, the spices of the Moluccas, opium, indigo imported from Hindustan; gold and silver, the first collected in Sumatra, Borneo, and some of the other islands. The maritime country trade of the Asiatic islands is carried on chiefly by the Chinese in their junks and brigs, by the Arabs in square-rigged vessels, and by the Bugis, the inhabitants of Celebes, who are all bold and expert navigators.

From the E. the annual fleet of Chinese junks arrives with the favourable monsoon among these islands, from Canton, Amoy, and other provinces, with cargoes of teas, raw silk, silk, piece-goods, and innumerable minor articles, for the use of the Chinese, who are settled in great numbers here, and are distinguished by their shrewd, intelligent, and industrious habits. The Chinese extend their voyages to Sumatra, the Straits of Malacca, and eastward as far as the Moluccas and Timor, collecting edible bird-nests, biche-de-mer, and other articles of which Java is the great entrepôt. Java is also a great depot of European goods; and the people being rather industrious cultivators of their fertile island than mariners or traders, it exports rice, a variety of vetches, salt, oil, tobacco, timber, brass-wire, and its own cloths, and a considerable quantity of European, Indian, and Chinese goods, in exchange for gold dust, diamonds, camphor, benjamin, and other drugs; edible bird-nests, biche-de-mer, rattans, bees-wax, tortoise-shell, and dyeing woods from Borneo and Sumatra. The rice and other productions of Java are exchanged for spices and pungent oils of the Moluccas, and for the tin of Banca. The natives of Celebes are famed for the manufacture of a particular species of fine cloths, of a very strong texture, which are in great request, and, along with spices, wax, and sandal-wood, are exchanged for the produce of Sumatra, Borneo, and Java, whence they are exported to China. The Bugis have a large share of the carrying trade of the Asiatic Archipelago; and they bring the produce of the Moluccas, and of Borneo and Sumatra, to Java and the other islands, and receive in exchange tobacco, rice, and salt, from Java, besides opium, iron, steel, European chintzes, and broad cloths and Indian piece goods, with which they return eastward during the south-west monsoon.[1]

The eastern countries of Asia, viz. India and China, as we have already stated, have from time immemorial been famed for certain manufactures, such as silks, cambrics, muslins, &c., as well as for other products peculiar to the climate, viz. spices, precious aromatics, medicinal herbs, &c. These were always in great demand in Europe, while the produce of Europe was not wanted in Asia. From the rude state of industry among the Western nations, they had nothing to offer in exchange for the finer manufactures of India, and still less could the soil of Europe yield any equivalent for the more genial produce of Eastern climes. Hence the great article of export in those times from Europe to Asia was always bullion, the instrument of exchange all over the world. Bullion could only be procured by an exportation of European produce or manufactures at such low prices as to insure a sale; and the loss on such transactions must have been made up to the merchant by the high price of Asiatic goods. The ancient monopoly of silk secured to Asia a favourable balance of trade with Europe, bullion being the only article with which it could be purchased. Notwithstanding the introduction of the silk manufacture into Europe about the sixth or seventh century, the commercial pre-eminence of Asia still continued, and bullion was the chief article of export to the East. Throughout the interior of Asia this superiority remains to the present day; and a continual stream of bullion flows from the Bosphorus eastward through Asia Minor and Persia into Hindustan, and is finally dispersed in the great ocean of the Chinese currency. Bullion is also the principal article sent from Arabia to India in exchange for Indian goods.

But a great revolution has taken place in the trade between Asia and Europe, and especially with Great Britain. Europe is now in a condition to offer an equivalent in manufactures for the produce of Asia; goods of various kinds are sent in exchange for those of India; and from Great Britain remittances in bullion have nearly ceased. So prodigiously has the price of goods been lowered by the use of machinery, that the cotton wool of India is now imported into Britain, and, after being manufactured, is re-exported to the place of its growth, and sold at a lower price than the same goods from the loom of the Indian workman, though it is loaded with the expense of a double voyage across half the globe. The goods of the European manufacturers are poured into Asia through all its seaports, and reaching the interior on the backs of mules and asses, often after a journey of several thousand miles over deserts and mountains covered with perpetual snow, they are sold cheaper than the same articles by the native workmen. The woollen manufactures of Yorkshire, the cotton goods of Manchester and Glasgow, French cloths, and German linens, are dispersed all over India, and even partially in China; they are found in the bazaars of Bokhara, Samarcand, and Cashgar, and are carried eastward by the caravans into the wilds of Tartary. The natural productions of Asia, namely, spices, rich aromatics, dyes, and other rare luxuries of tropical climates, will always be in demand in Europe; and the monopoly of tea by the Chinese gives them the command of the European markets. Tea has now almost become one of the necessaries of life, and it travels for a market across half the globe. It is the great commercial link between Europe and China, from which, like the precious produce of silk in ancient times, it can only be procured. But the improved industry of Europe supplies, as already observed, an equivalent in woollen and cotton goods for this highly-prized luxury. Since the expiry of the charter of the East India

[1] Raffles' *History of Java*: Marsden's *Sumatra*.

Company in 1834, the trade has been thrown open to all classes of British subjects, and our merchants can now freely trade to all places accessible to Europeans to the E. of the Straits of Malacca. During the short time that has elapsed since then, the increase of the exports and imports have fully realized the expectations held out by those who opposed the Company's monopoly. See HINDUSTAN. (H. M.) (W. P—E.)

ASIA MINOR. From the unsettled state of this country, once the seat of early civilization and the cradle of the fine arts, it is now comparatively imperfectly known, and the accounts left us by ancient writers are very meagre and unsatisfactory. It is, however, of perhaps greater interest to the geographer, the historian, and the antiquary, than almost any other country. It everywhere abounds with relics and monuments of antiquity, all tending more or less to throw light upon the history of the human race. It may be true that Asia Minor was only of secondary importance in the palmy days of Assyria and Egypt,—when science, literature, and arts flourished in Greece, or when Rome sat mistress of the world; but these rose to eminence for a short time, only to fall into a greater depth of barbarism, whereas it has maintained a greater or less degree of importance from the first dawn of history to the present time. But even apart from its historical interest, the country itself presents much to recommend it to notice. The grandeur and picturesque beauty of its scenery renders it at least equal, if not superior, to any country of Europe, while its extreme productiveness, coupled with the number of its excellent ports and other advantages, give evidence, that under a more favourable system of government it might become a place of importance in a commercial point of view; but at present its imports are subject to very heavy and arbitrary taxes, and almost every branch of industry is paralyzed by the still more ruinous system of monopolies.

When the descendants of Noah were, from their numbers, obliged to disperse themselves over the earth, the family of Lud, one of the sons of Shem, is supposed to have been the first to people the wilds of Asia Minor, and to have at length settled on the banks of the Hermus. The traditionary Lydus, the eponymous king of the Lydians, is supposed to be the same with Lud, and his grandfather Manes is probably the Noah of Scripture. It is not our intention, however, to follow out here the history of the country, as that will be found in other parts of the work. Suffice it to say, that Asia Minor was the theatre of the earliest remarkable events recorded in profane history, as the Argonautic Expedition, the Trojan War, in which the gods are said to have descended from Olympus and joined battle with mortals; the conquests of the Persians, the overthrow of their empire by Alexander, and the settlement in this part of Asia of his successors. It subsequently fell under the Roman sway, and suffered severely in after ages in the wars of the Saracens, the Turks, Tartars, &c. It is also intimately connected with the early history of Christianity, and the first Christian churches were planted here.

From the earliest times till after the establishment of the Roman power in Asia Minor, that country, or a part of it, went under the general name of Asia. Homer and others apply this term to the valley between Tmolus and the Caystrus. When the Romans extended their conquests beyond the peninsula, they divided their Asiatic territory into *Asia intra Taurum*, and *Asia extra Taurum*. The term Asia Minor seems to have been adopted about the fourth century of our era, and was applied to that peninsula of Asia extending westward from an imaginary line drawn from Trebizond to the Gulf of Scanderoon. It comprehended Mysia, Lydia, Caria, Lycia, Pisidia, Cilicia, Bithynia, Paphlagonia, Pontus, Phrygia, Galatia, Lycaonia, Cappadocia, and Armenia Minor.

Most of the works of the ancient geographers and historians on this country are now lost, with the exception of Strabo, Pliny, Ptolemy, Stephen of Byzantium, and a few others. Accounts of several military expeditions into the country are, however, extant, as Xenophon's account of the expedition of Cyrus the younger; Arrian's history of the Asiatic expedition of Alexander the Great; the history of the Roman wars in Asia, by Polybius, Livy, and Appian, particularly Livy's account of the Marches of the Consul Manlius through Phrygia, Pamphilia, Pisidia, and Galatia, to Ancyra; Anna Comnena's account of her father Alexis Comnenus' expedition against the Turks. Among modern travellers in this country are Tavernier, Tournefort, Pococke, Niebuhr, Beaufort, Kinneir, Richter, Leake, Keppel, Arundell, Fellow, Texier, Hamilton, Chesney, Ainsworth, &c. The work, however, which promises to throw most light upon this interesting country is that by the recent traveller Tchihatcheff, entitled *Asie Mineure, Description Physique, Statistique, et Archeologique*. The first volume has lately been published, and is devoted to the physical geography; the second is to treat of the meteorology, botany, and zoology; the third of the geology; and the fourth is to give a statistical and archæological account of the country.

The peninsula of Asia Minor is the most western territory of Asia, and extends northward from the Mediterranean to the Euxine, and eastward from the Grecian Archipelago to the banks of the Euphrates. Its length from E. to W. is nearly 600 miles, and its breadth about 360, lying between Lat. 36° and 42° N., and Long. 26° and 40° E. It is divided into the pashaliks of Anatolia, Livas, Karamania, Isthil, Adana, Marash, and Trebizond. The principal towns are Smyrna, Trebizond, Brusa, Angora, Konieh, and Kaisaryeh.

It may be described as an elevated table-land, consisting principally of a succession of extensive plains, frequently furrowed by deep valleys, and intersected by lofty chains of mountains. The limits of this extensive upland, containing these plains and valleys, are marked by an elevated and almost continuous chain of mountains, round which, at a lower level, a succession of narrow plains border the shores of the Mediterranean and Black Seas. The Taurus mountain chain extends from E. to W., near its southern coast, rising frequently to the height of 8000 or 10,000 feet; and along the northern coast is another chain rising to the height of 6000 or 7000 feet, and comprising Mount Olympus and Mount Ida of antiquity. On the S.E. are the mountain chains of the Anti-Taurus, the loftiest point of which, Arjish Tagh, attains the height of 13,000 feet.

The coast of Asia Minor is deeply indented by bays and gulfs, particularly on its western and southern sides. Along the western coast there are numerous deep and well-sheltered harbours, as well as in that part of the southern belonging to Lycia, while those of the northern coast are all more or less exposed to the action of the winds. Asia Minor contains several lakes, some of which receive streams but emit none, evaporation being sufficient to preserve their level. The *Tuzla*, or salt lake of Koch-Hissar, situate nearly in the centre of Asia Minor, is stated to have only a circumference of 30 leagues, although it is 50 miles in length. Its waters are so salt that no fish exist in it; and birds are said to avoid it, as when they alight on it their plumage instantly becomes incrusted with salt so as to impede their flight. Wood thrown into it is immediately incrusted with salt. Vestiges of a causeway that once crossed it are nearly concealed by a coating of salt; and in some places the bottom is a solid mass of muriate of soda. This salt is collected at four places, and is a government monopoly. Its

surface is 2500 feet above the level of the Mediterranean. In the language of the adjacent district it bears the names of *Tuz-choli* (salt desert) in summer, when partially dried up; *Tuz-Goli* (salt lake), *Agi-goli* (bitter lake), or *Koch-Hissar-goli* (lake of Koch-Hissar.) Southward of this lake, towards the Gulf of Adalia, are several other lakes; one of these, *Egerdir*, is a fine fresh-water lake, 30 miles long, surrounded by lofty branches of the Taurus, clothed with forests. The lake of *Beg-shehr*, also fresh, is about the same size, and discharges its superfluous waters by a considerable stream into the lake of *Seidi-shehr*, or *Soghlah*, which has no visible outlet, but is fabled to have a subterranean passage through the chain of the Taurus. The other lakes deserving notice are those of *Ak-shehr*, *Eber-Ghieul*, *Ak-Ghieul*, near Eregli; *Mangas-Ghieul*, and *Ulubad*, or Apollonia, to the S. of the Sea of Marmora.

The principal river of Asia Minor is the *Kiril-Irmak*, which has a tortuous course of above 400 miles through the eastern part of that region, and falls into the Euxine. It is the celebrated Halys of antiquity. The other principal streams falling into the Black Sea are the *Jehil-Irmak*, the Jorukh, and the Sakaria; while the Caïcus, the Hermus, Cayster, and Mæander with its three affluents, now individually the *Grimalki*, Sarabat, and Meinder-su, pour their waters into the Mediterranean.

The mountain ranges of Asia Minor seem to be principally composed of limestone reposing on granite, quartz-rock, and schists, with secondary formations on their flanks; in the valleys, tertiary and lacustrine deposits, ancient and modern igneous rocks, and recent sedimentary accumulations. The micaceous schist and associated rocks, however, form a great part of the mountain chains which intersect the western portion of the peninsula. Tertiary lacustrine formations occur in almost every valley, and secondary deposits, with organic remains, are found in several places. Trap-rocks are of frequent occurrence, and trachyte is abundant in the western part of the country. About 90 miles eastward of Smyrna is the district of Katakekaumene, or burnt-up country, about 19 miles in length and 8 in breadth. It consists of mounds of erupted rocks, referable to two epochs; the older cones are low and flat, their craters only marked by slight depressions, or have entirely disappeared; the more recent ones, three in number, still retain their forms unaltered, though they have been extinct for more than 3000 years. The former are covered with vineyards which produce the Katakekaumene wine, celebrated since the days of Strabo.

The climate in the lower parts of the country bears a considerable resemblance to that of Southern Europe. The soil, except in the rocky districts, is very fertile and well watered. A large portion of the surface, particularly in the territory bordering upon the two seas, consists of a fine alluvial soil, covered with rich herbage, or the finest grain crops. The mountain ranges are in many places mantled with extensive forests of pine, beech, chestnut, walnut, plane, and mulberry, while the plains and valleys produce oranges, lemons, grapes, figs, and olives.

The chief productions of the country are silver, copper, iron, lead, and alum; grapes and other fruits; grains, silk, cotton, hemp, flax, tobacco, opium, saffron; madder, mastic, and other gum resins, galls, skins, hides, wool, goats' hair, leeches, sponges, wax, honey, salt, and some wine. The imports are confined chiefly to coffee, sugar, spices, cutlery, and cloths.

The principal inhabitants of Asia Minor are Osmanli, or Othman Turks. In the interior are several nomade tribes of Turkomans, Kurds, and Yorukhs; of these the Turkomans are the most numerous and civilized. Like the Osmanli, they are a branch of the great Turkee family, and speak a kindred dialect. In summer they live in tents, but in winter are generally inhabitants of villages. They possess large herds of camels, buffaloes, sheep, and goats. They have also a fine breed of horses, which they dispose of, with flesh, butter, and milk, to the inhabitants of the adjacent towns and villages, in exchange for money, arms, and articles of clothing. Their women spin wool and weave handsome carpets. Each camp or village is under a chief, whose power is regulated by custom and the habits of his tribe. They pay to the pasha of the province they inhabit a certain rate per cent. for the privilege of pasturage in the uncultivated lands. The Kurds are inclined to pillage travellers, and inhabit the wilder parts of the country. The Yorukhs live in tents throughout the year, among the mountains generally; and when near towns they cultivate a little ground, and are usually the charcoal burners of the district.

See Beaufort's *Karamania*, Lond. 1817; Leake's *Journal of a Tour in Asia Minor*, Lond. 1824; Rennel's *Geography of Western Asia*, Lond. 1831; Arundell's *Visit to the Seven Churches*, Lond. 1828; Arundell's *Discoveries in Asia Minor*, Lond. 1834; Hamilton's *Asia Minor*, Lond. 1842; Chesney's *Expedition to the Euphrates*, Lond. 1850; Tchihatcheff's *Asie Mineure*, Paris, 1853; various Papers in the *London Geographical Journal*.

ASIATIC SOCIETIES. Numerous associations of learned men have, within a comparatively modern date, been formed for the purpose of adding to our knowledge of Eastern countries in the various departments of science and literature. The oldest society of this kind was founded by the Dutch in Batavia. Its transactions, published at Batavia from 1780 to 1833, form 15 volumes. The next was the *Royal Asiatic Society of Bengal*, founded at Calcutta in 1784 by Sir William Jones. Its transactions from 1788 to 1832 appeared under the title of *Asiatic Researches*, and afterwards as the *Journal of the Royal Asiatic Society of Bengal*, to which the accomplished editor Mr Prinsep contributed his researches in Indo-Bactrian and Persian numismatics.

In 1823, the *Royal Asiatic Society of Great Britain and Ireland* was established at London by Mr Colebrooke, assisted by Ouseley, Staunton, Wynn, and other eminent orientalists. The literary societies of Bombay and Madras were subsequently incorporated as branches of this society. Since 1833, its transactions have been published in the society's journal, published quarterly, of which vol. xiii. appeared in 1852. To this journal Major Rawlinson has contributed his valuable researches on the ancient cuneiform inscriptions of Persia. This society possesses a valuable library and museum. Connected with it is the *Oriental Translation Committee*, instituted in 1828, which has published versions in English, French, and Latin, of many valuable oriental works, as well as several original texts.

The *Société Asiatique* of Paris was founded in 1822, by the distinguished oriental scholars Silvestre de Sacy, Abel-Remusat, Saint Martin, Chézy, Klaproth, Degérando, &c. Its transactions appeared monthly under the title of *Journal Asiatique*, until January 1828, when it took the name of *Nouveau Journal Asiatique*. This society has published many important works. It holds an annual public meeting, and has a good museum. An oriental institution, with chairs of Oriental languages and a museum, is supported at St Petersburg by the government. In Germany there is the *Deutsche Morgenländische Gesellschaft*, of the journal of which 6 vols. have appeared at Leipzig. The *Zeitschrift für die Kunde des Morgenländes*, begun at Göttingen in 1837, is now edited at Bonn, by the eminent orientalist Lassen. The labours of German orientalists have also found a place in the well-known collection entitled *Mines de l'Orient*.

The *American Oriental Society* issues a journal, of which 2 vols. have appeared.

ASIARCHÆ (termed by St Paul, *Chief of Asia*, Acts xix. 31) were the Pagan pontiffs of Asia, chosen to superintend the public games, which they did at their own expense. They were always persons of high consideration.

ASIENTO (a Spanish word signifying a *seat*, a *contract*), in *Commerce*, was used to denote a treaty between the king of Spain and other powers, for importing negroes into the Spanish dominions in America.

ASINARA, a small island of Italy on the western coast of Sardinia, with good coral fisheries. Long. 8. 15. E. Lat. 41. 5. N.

ASINIUS POLLIO, a Roman consul and orator, who distinguished himself under Augustus by his exploits and literary works. He is frequently mentioned with praise by Horace and Virgil, and is said to have collected the first library at Rome. He died at Frascati, at eighty years of age, A.D. 4. None of his works are extant.

ASKEATON, a small town of Ireland, county of Limerick, on the river Deel, two miles from its junction with the Shannon. It was founded by the Desmonds, and has remains of a fine Franciscan house, and a castle. Pop. in 1851, 1957.

ASKERN, a place six miles from Doncaster in Yorkshire, noted for its sulphureous springs.

ASKEW, or ASCUE, ANNE, one of the numerous victims to the cause of the Reformation in the year preceding the death of the tyrant Henry VIII., was a lady of great merit and beauty, of a good family in Lincolnshire, and in correspondence with Queen Catherine Parr, and the chief ladies of the court. She had studied the Scriptures, and denied the real presence in the Eucharist, for which a bigoted husband expelled her from his house. On coming to London she was arrested, and interrogated by Chancellor Wriothesley and Bishop Bonner; at the instigation of whom, under threats of torture, she signed a qualified recantation. She was imprisoned, and wrote to the king, says Hume, "that as to the Lord's Supper she believed as much as Christ himself had said of it, and as much of his divine doctrine as the Catholic Church had required. But while she could not be brought to acknowledge the king's explications, this declaration availed her nothing, and was rather regarded as a fresh insult." She was most cruelly racked in the presence, and it was said by the hand, of the chancellor himself, in order to extort confession of those ladies about court with whom she corresponded. Her fortitude and fidelity probably saved the life of the queen and others. She disclosed nothing, although her limbs were so dislocated by the rack that when condemned to be burnt alive she could not stand, and was carried in a chair to Smithfield, where, on 16th July 1546, she underwent this terrible mode of execution with undaunted courage, along with four other victims of an atrocious tyranny.

ASKRIGG, a market-town and polling-place in the North Riding of Yorkshire, on the Ure, 15 miles S.W. of Richmond.

ASMODEUS. See ABADDON.

ASMONEUS, or ASSAMONEUS, the father of Simon, and chief of the Asmoneans, a family that reigned over the Jews 126 years.—Josephus, *Hist. Jud.*

ASNA. See ESNE.

ASOLO (ancient *Acelum*), a town of Austrian Italy, 18 miles N.W. of Treviso. It is well built and finely situated; has a cathedral and several other churches, with an ancient castle, and the remains of a Roman aqueduct, &c Pop. 3500. Long. 11. 58. E. Lat. 45. 50. N.

ASOPH. See AZOPH.

ASP, in *Natural History*, a poisonous kind of serpent. It is said to be thus denominated from the Greek ἀσπὶς, *a shield*, in regard to the manner of its lying convolved in a circle, in the centre of which is the head, which it exerts or raises like the umbo or umbilicus of a buckler. This species of serpent is very frequently mentioned by authors, but so carelessly described that it is not easy to determine which, if any, of the species known at present may properly be called by this name. It was with the asp that Cleopatra is said to have despatched herself, and prevented the designs of Augustus, who intended to have carried her captive to adorn his triumphal entry into Rome. But the fact is contested: Sir Thomas Brown places it in the list of vulgar errors. The indications of that queen's having used the ministry of the asp were only two almost insensible pricks found in her arm; and Plutarch says that the cause of her death is unknown. Naturalists now suppose the asp of the ancients to be a species of viper, either the *V. Echis* or *V. Cerastes* of Schlegel; and some suppose it to be the *Naja Haje.*

ASPARAGUS. See HORTICULTURE.

ASPARAGINE. See CHEMISTRY.

ASPASIA of Miletus, a celebrated courtezan who settled at Athens under the administration of Pericles. She was of admirable beauty; yet her wit and eloquence, still more than her beauty, gained her extraordinary reputation among all ranks in the republic. Her conversation was so entertaining and instructive, that notwithstanding her dishonourable profession, persons of the first distinction, male and female, resorted to her house as to an academy. It is said that she even numbered Socrates among her hearers. She captivated Pericles in such a manner that he dismissed his own wife, to make way for Aspasia, who, by her universal knowledge, irresistible elocution, and intriguing genius, in a great measure influenced the administration of Athens. She was accused of having excited, from motives of personal resentment, the war of Peloponnesus. The companions of Aspasia served as models for painting and statuary, and themes for poetry and panegyric. Nor were they merely the objects, but, as is said, the authors of some literary works, in which they established rules for the behaviour of their lovers, particularly at table; and explained the art of gaining the heart and captivating the affections.

ASPECT, in *Astronomy*, the position of one planet with respect to another.

ASPECTANT, in *Heraldry*, signifies face to face; as when two beasts or birds are borne opposite to each other in the shield.

ASPER (*Spiritus*), in *Grammar*, an accent peculiar to the Greek language, marked thus ʽ, and importing that the letter over which it is placed ought to be strongly aspirated, or pronounced as if an *h* were prefixed.

ASPERN, or GROSS ASPERN, a village of Austria on the left bank of the Danube, a few miles below Vienna. This village and the neighbouring one of ESSLING are celebrated as the scene of a tremendous conflict between the French army commanded by Napoleon, and the Austrians under the Archduke Charles. After two days hard fighting (21st and 22d May 1809), with great loss on both sides, the French were obliged to take refuge in Lobau, a small island in the Danube; but Napoleon speedily retrieved his losses on the field of Wagram.

ASPEROSA, a town and bishop's see of Turkey in Europe, situated on the coast of the Archipelago. Long. 25. 20. E. Lat. 40. 58. N.

ASPERMOUS (α, priv., and σπέρμα), in *Botany*, destitute of seed.

ASPHALTITES LACUS, or LAKE OF BITUMEN, so called from the bitumen which floats upon its surface. The Arabs call it *Birket Lut*, "the Sea of Lot." It is more familiarly known as the DEAD SEA, a name associated with many fables, and derived from a long standing belief that no creature could live in its waters, or within reach of its pes-

tiferous exhalations. It lies between Lat. 31. and 32. N. Long. 35. 40. E.

This celebrated lake is supposed to occupy the site of the ancient plain of Sodom and Gomorrha; and this belief may possibly have given rise to the idea of its deadly exhalation. It is, indeed, possible that when the volcanic agencies that appear to have torn and upheaved its rocky southern borders were in operation, such emanations may have taken place, but these have long ceased. Early in the Christian era Pliny merely states that the Essenes, a tribe dwelling on its banks, abandoned their stations on the approach of summer as unwholesome; just as other lakes in warm climates are pestilential at that season from marsh miasms. In the present day the air over it has nothing peculiarly pestilential. It has been repeatedly visited, and the supposed absence of animal life on and in its water is found to be fabulous. Heymann and Van Egmont observed swallows skimming along its surface; and a sparrow, which they had thrown into the lake after clipping its wings, easily regained the shore. Captain Lynch of the U. S. navy, saw ducks on its surface, and snipes, partridges, singing birds, and hares, on its shores. Some travellers have ascertained that the coral *porites elongata* lives in its waters; and Hasselquist and Maundrell long ago mentioned living shells as occurring in it. Dr Wilson observed shells of dead Clausilia and Pupa on its shores, which he supposes to have been carried into it by the Jordan, but may very well have lived there and been ejected after death on the beach. It has even been asserted that one small species of fish is peculiar to the Dead Sea. This designation of the lake seems to have arisen from the little agitation of its very dense waters by the winds, and the dull murmur they make on its shores. Its surface very speedily resumes its unruffled appearance on the ceasing of a gale, and is scarcely curled by a moderate breeze.

The lake occupies a portion of a very remarkable depression of the earth's surface, the Wady-el-Ghor Within the present century its surface has been found to be greatly below the level of the Mediterranean. The problem was attempted by Schubert and Russegger with the barometer; but it was more accurately determined by a series of levels taken by some French engineers, and by Lieut. Symonds of our Royal Engineers. The levels of the latter, carried from Jaffa to the Dead Sea, give the depression of the surface of the latter at 1312·2 feet. The French state it at 1446 feet below the Mediterranean, and 1407 below the Red Sea. The determination of Captain Lynch, U. S. navy, nearly agrees with that of Symonds. Three attempts have been made to survey it by boats; the first by Mr Costigan, an enterprising young Irish traveller in 1835; the next by Lieut. Molyneux, R.N., in 1847. Exposure to the sun proved fatal to both. In 1848, Captain Lynch was sent with iron boats and suitable apparatus by the American Government to survey the Dead Sea, and the result has been published. The lake is stated by Symonds to be $48\frac{1}{2}$ English miles in length, and $11\frac{1}{2}$ at its greatest breadth. Lynch makes its extreme length to be 42 miles from north to south, and rather less than 10 at its widest part. These measurements are much below its fancied dimensions. Even Mariti states its circumference at 180 miles. Its depth is very considerable. The greatest depth, according to the observations of Molyneux, is 225 fathoms; and even then it was uncertain whether the plummet struck the bottom. In the northern portion, between Ain-Jidi to the mouth of the Arnon, the mean depth, according to Lynch, for a distance of seven geographical miles, was 188 fathoms. The southern portion of the lake is shallow, and is divided from the deep part by a narrow peninsula of loose calcareous marl. To the south of this peninsula the depth is only about 13 feet. With regard to the bottom of the lake, it is in part rocky, but generally consists of a bluish mud or slime, containing cubic crystals of salt. Bitumen and asphalt are found on the east and west shores of the lake, with small masses of sulphur, especially at the end of the peninsula which Lynch has named Cape Costigan, a bluff 40 or 50 feet high, with an angular ridge 20 feet higher. The sulphur is occasionally in masses as large as a walnut, and the asphalt is manufactured into rosaries at Jerusalem. The north shores of the lake Lynch describes as an extensive flat of mud, with sandy plains beyond, and as the very type of desolation, with the blackened trunks and branches of trees strewed in every direction, partially encrusted with salt. The north-west shore consists of a bed of gravel sloping gently to the hills. The eastern shores are formed by the rugged sterile mountains of Moab, a branch of the Hauran range. The southern shore is low, flat, and marshy, of the most desolate aspect. The whole line of the west coast is formed of a range of rugged mountains like the eastern side. At the south-west extremity of the lake is the isolated ridge called the Mountain of Usdom, containing fossil salt. Here Lynch found a lofty detached pillar of salt, standing at the head of a deep narrow chasm. It is cylindrical in front, and pyramidal behind; it is of solid crystalline salt, capped by carbonate of lime. The upper part is 40 feet high, resting on an oval pedestal 40 or 50 feet above the water. It slightly diminishes in diameter as it ascends, and the top is of crumbling limestone. It is probably this pillar of salt which some travellers have mentioned as known to the Arabs under the name of "Lot's Wife."

Captain Lynch's survey was leisurely made; his boats were 22 days on the lake. He encountered a sudden squall on one occasion, when the sound of the waves against the boats is described as like that of sledge hammers rather than of waves of the sea; yet when the squall as suddenly ceased, within 20 minutes they were rowing along a placid sheet of smooth water scarcely rippling to the breeze. This comparative sluggishness of its waters is owing to their great density, which has no parallel except in the lately discovered Utah Lake of North America. Lynch once observed the sea extremely phosphorescent; which appearance we now believe to be produced by medusaria and other minute animals—a further proof that the waters of this celebrated lake are not hostile to life. The water, when examined in a glass, is clear and transparent; but Molyneux found it throughout at the period of his visit muddy like the waters of the Jordan; and he also speaks of its disagreeable smell. It has been chemically examined by Macquer, Lavoisier, Sage, Marcet, Klaproth, and last by Dr Salisbury of America. Its specific gravity as given by Lavoisier = 1·240; by Klaproth, 1·24; by Marcet, 1·211; by Salisbury, 1·1877. These differences may depend on the season of the year, and the proximity to the Jordan or the Arnon. Certain it is that its waters are far more buoyant than those of the Mediterranean. The ancients believed that men and animals, and even iron, floated entirely on its surface. Mr Stephens, a late American traveller, states that when he made the experiment, lying on his back without any motion of his hands, half his body remained above the surface, and he could easily have read in that position; although in the Mediterranean he could only float when using some slight motion of his hands.

The analysis of the water has been differently stated by eminent chemists; thus we have for its contents—

	Marcet.	Klaproth.
Muriate of lime	3·920	10·60
Muriate of magnesia	10·246	24·20
Muriate of soda	10·360	7·80
Sulphate of lime	0·054	0·00
	24·580	42·60
Water	75·420	57·40
	100·000	100·00

This striking difference probably depends on two causes:

Asphaltum ‖ Assafœtida.

the loss of some water by evaporation in the keeping of the specimen of water before analysis; and the difference in drying the salts before weighing them. That this last cause is very important we know; and Marcet found that when the saline ingredients were dried only at a temperature of 180° Fahr., they equalled 41 per cent. of the water examined. The analysis given by Dr Salisbury in the *Transactions of the American Scientific Association for* 1851, gives also minute quantities of potass, bromine, sulphur, silica, alumina, peroxide of iron with nitric, phosphoric, and carbonic acid, and organic matter, as ingredients in the waters of the Dead Sea; and no doubt he would also have found in them *iodine*, but his method of stating the proportions of each, while the bases of the other salts only are given, renders quantitative comparison unsatisfactory. He, however, states the ponderable contents of the water at 23·002 per cent. He further states that a gallon weighed 11·877 lb.; a cubic foot 71·175 lb., while that of distilled water only 62·32 lb.

The saltness of the lake is derived from extensive beds of salt that occur on its shores. At Usdom these beds extend five geographic miles in length, and form cliffs from 100 to 150 feet in thickness. The waters of the Jordan, though potable, contain exactly the same kind of saline substances as the lake; and as it has no outlet, the supply brought by the Jordan, the Arnon, and its other tributaries, must be removed by evaporation, leaving the salt behind; so that in process of time the lake may become a bed of fossil salt. The rugged mountains of Moab have all the character of erupted rocks; and the sulphur and bitumen, with the large disengagement of bubbles of gas from the deepest part of the lake, are probably indications of slumbering volcanic action. (T. S. T.)

ASPHALTUM, BITUMEN JUDAICUM, or JEW'S PITCH, is a light, solid bitumen, of a dusky colour on the outside, and a deep shining black within; of very little taste, and having scarcely any smell, unless heated, when it emits a strong pitchy odour. It is found in a soft or liquid state on the surface of the Dead Sea, and by age grows dry and hard. The same kind of bitumen is met with likewise in the earth in other places of the world—in China, America, and in some places of Europe, as the Carpathian Hills, France, Neufchatel, &c. See BITUMEN.

ASPHODELEÆ, a natural order of plants, containing, among others, the well-known vegetable, *asparagus*. This plant, and the root of the marsh-mallow, yield the chemical principle asparagine. See CHEMISTRY.

ASPHYXIA (ἀσφυξια), a temporary suspension of the motion of the heart and arteries, causing swooning or fainting.

ASPICUETA, or AZPILCUETA, MARTIN DE, commonly called the Doctor of Navarre, was descended of a noble family, and born on the 13th of December 1491, at Varasayn, near Pampeluna. He studied classics, natural and moral philosophy, and divinity, at Alcala in New Castile. After teaching with applause at Toulouse and Cahors, he was professor of canon law at Salamanca for 14 years, and afterwards at Coimbra for 20 years. Pope Pius V. made him assistant to Cardinal Francis Aciat, his vice-penitentiary; and Gregory XIII. never passed his door without calling for him, and stopped sometimes a whole hour to talk with him in the street. He was consulted as an oracle; and his name became so famous, that even in his lifetime the highest encomium on a learned man was to call him a *Navarrus*. He died on the 21st June 1586, having by temperance prolonged his life to the age of 94. He wrote a number of treatises on morality, law, &c. These were published in 3 vols. folio, Rome, 1589; and in 6 vols. 4to, Venice, 1602.

ASS. See MAMMALIA.

ASSAFŒTIDA, a fœtid gum resin, obtained by exudation from the roots of at least two species of umbelliferous plants, *Ferula Assafœtida* and *F. Persica*. The best comes from Persia and Herat. Another locality has lately been assigned on the northern slope of the Himalayas in Sŷghan. That produced in Northern Persia from *F. Persica*, is inferior in quality to that of Eastern Persia. See BOTANY.

Assam.

ASSAM, a province of Eastern India, situate in the north-east of the Bengal territory, between the 25th and 29th degrees of north latitude, and the 90th and 97th degrees of east longitude. Its boundaries are Bhotan on the north and north-west; Thibet on the north-east; Burmah on the south-east; Cachar, Jyntea, and the tract inhabited by the Cossya tribes on the south; and the district of Goalpara on the west. Assam is an immense valley, surrounded on all sides, except upon the west, by mountains of considerable elevation, and interspersed with numerous eminences in the interior, rising abruptly from the general level. The whole superficies is calculated at 21,805 sq. miles, a large portion of which is occupied by woods and rivers. Probably the rivers intersecting Assam are more numerous than those of any other country of equal extent, a consequence resulting from its being environed by hills. The valley is divided throughout by the Brahmapootra into two nearly equal parts; and many islands, some of them very large, are formed by the confluence and mutual intersection of numerous rivers, which contribute alike to fertilize the ground and to facilitate the intercourse of the inhabitants. Of these rivers not less than sixty-one are known and distinguished by particular names, of which thirty-four flow from the northern, twenty-four from the southern mountains, and the remainder from sources beyond the confines of Assam. The streams of the south are not rapid, and have no considerable current until May or June.

Boundaries, rivers, and natural features.

The Brahmapootra, one of the largest rivers in the world, derives its source from a well or circular basin at the eastern extremity of the Brahmakund valley; it enters Assam not by a deep chasm, but by a series of cascades caused by the accumulation of blocks of stone which have been propelled forward by the torrent, and thus create a succession of rapids. Its earliest feeders after crossing the frontier are the Kundil and the Digaroo, flowing from the Mishmi Hills on the north, and the Tenga Pence and Noh Dihing which take their rise on the Singpho Hills to the south-east. Shortly afterwards it receives the Dibong, flowing from the north-east; but its principal confluent is the Dihong, which deriving its origin under the name of the Sanpoo, from a spot in the vicinity of the source of the Sutlej, flows in a direction precisely opposite to that river, and traversing the table-land of Thibet at the back of the great Himalaya range falls into the Brahmapootra in Lat. 27. 48., Long. 95. 26., after a course of nearly 1000 miles. Doubts were long entertained whether the Dihong could be justly regarded as the continuation of the Sanpoo; these, however, have been gradually removed by the additional testimony of more recent notices; and as it is ascertained moreover that the last-named river does not flow into the Irawaddy, it appears impossible to account for its course to the sea, except by presuming it to discharge its waters into the Brahmapootra through the channel of the Dihong. Below the confluence the united stream flows in a south-westerly direction, forming the boundary between the districts of Luckimpore and Durrung, situate on its northern bank, and those of Sudiya, Seebpoor, and Nowgong on the south; and finally bisecting Camroop, the lowest of the six districts into which Assam is distributed, it crosses over the frontier of the province and passes into Bengal. In its course it receives on the left side the Booree Dehing, a river having its rise at the south-eastern angle of the province; and lower down on the opposite side it parts with a considerable offset termed the Booree Lohit, which, however, reunites with the Brahmapootra 60 miles below the point of divergence, bearing with it the additional waters of the Sobu Sheree flowing from Thibet. A second offset under the name of the Kul-

Assam.

lung River rejoins the parent stream a short distance above the town of Gowhatty. The remaining rivers are too numerous to be particularized. Among the islands formed by the intersection and confluence of the rivers is Majuli, or the Great Island, as it is called by pre-eminence. This island extends 55 miles in length by about 10 in breadth, and is formed by the river Brahmapootra on the south-east, and the Booree Lohit on the north-west. A Persian writer, Mahommed Cazim, in describing Assam at the latter end of the seventeenth century, makes some observations on its general appearance, which, as he bore no favour to the inhabitants, may probably merit the greater confidence. He thus speaks of Majuli—"an island well inhabited, and in an excellent state of agriculture; it contains a spacious, clear, and pleasant country. The cultivated part is bounded by a thick forest which harbours elephants, and where these animals may be caught as well as in four or five other forests in Assam. If there be occasion for them, five or six hundred elephants may be procured in a year." Describing the country south of the Brahmapootra, the same author observes, "across the river on the side of Ghergong is a wide, agreeable, level country that delights the heart of the beholder. The whole face of it is marked with population and tillage; and it presents on every side charming prospects of ploughed fields, harvests, gardens, and groves. From the village of Salagerah to the city of Ghergong, a space of about 50 coss (100 miles), is filled with such an uninterrupted range of gardens, plentifully stocked with fruit trees, that it appears as one garden. Within them are the houses of peasants, and a beautiful assemblage of coloured and fragrant herbs, and of garden and wild flowers blowing together. As the country is overflowed in the rainy season, a high and broad causeway has been raised for the convenience of travellers from Salagerah to Ghergong, which is the only uncultivated ground that is to be seen. Each side of this road is planted with shady bamboos, the tops of which meet and are entwined. Among the fruits which this country produces are mangoes, plantains, jacks, oranges, citrons, limes, and punialeh, a species of ambleh, which has such an excellent flavour that every person who tastes it prefers it to the plum. There are also cocoanut trees, pepper-vines, areca trees, and the sadij (an aromatic leaf), in great plenty. Sugar cane excels in softness and sweetness, and is of three colours, black, red, and white; there is ginger free from fibres and betel vines. The strength of vegetation and fertility of the soil is such, that whatever seed is sown, or slips planted, they always thrive. The environs of Ghergong furnish small apricots, yams, and pomegranates; but as these are wild, and not assisted by cultivation and engrafting, they are very indifferent. The principal crop of this country consists in rice and mash. Ades, a kind of pea, is very scarce, and wheat and barley are never sown." And in respect to the other great division of the province he remarks, "The country which is on the northern side of the Brahmapootra is in the highest state of cultivation, and produces plenty of pepper and areca nuts. It even surpasses the southern portion in population and tillage; but as the latter contains a greater tract of wild forests, and places difficult of access, the rulers of Assam have chosen to reside in it for the convenience of control, and have erected in it the capital of the kingdom. The breadth of the Northern Division from the bank of the river to the foot of the mountains, which is a cold climate and contains snow, is various, but is nowhere less than 30 miles nor more than 90. The inhabitants of those mountains are strong, have a robust and respectable appearance, and are of a middling size. Their complexions, like those of the natives of all cold climates, are red and white; and they have also trees and fruits peculiar to frigid regions." Various agricultural products appear to have been introduced since the time of Mahommed Cazim. Wheat and barley are now raised, though only to a small extent; but cotton, tobacco, and the poppy are extensively grown. The indigenous trees producing lac, and those yielding the gum known as caoutchouc, are of great importance. But perhaps the most valuable of the vegetable products of Assam is the tea plant. This was first discovered in 1823, while the country was part of the Burmese dominions, by Mr Robert Bruce, who had proceeded thither on a mercantile speculation. The war with the British breaking out shortly after, and a brother of the first discoverer happening to be appointed to the command of a division of gun boats employed in some part of the operations, he followed up the pursuit of the subject and obtained several hundred plants and a considerable quantity of seed. Some specimens were ultimately forwarded to the superintendent of the Botanic Garden at Calcutta. In 1832 Captain Jenkins was deputed by the Governor-general of India, Lord William Bentinck, to report upon the resources of the country, when the tea plant was brought to his especial notice by Mr Bruce; and in 1834 a minute was recorded by the Governor-general on the subject, to which it is said his attention had been called in 1827 before his departure from England. In accordance with the views of that minute, a committee was appointed to prosecute inquiries, and to promote the cultivation of the plant. Communications were opened with China with a view to obtaining plants and seeds from thence, and a deputation composed of gentlemen well versed in botanical studies was despatched into Assam. Some seeds were obtained from China; but this probably was of small importance, as it was clearly ascertained by the members of the Assam deputation, that both the black and the green tea plants were indigenous there, and might be multiplied to any extent; but another result of the Chinese mission, that of procuring persons skilled in the cultivation and manufacture of black tea, was of more material benefit. Subsequently, under Lord Auckland, a further supply of Chinese cultivators and manufacturers was obtained, these being acquainted with the processes necessary for the production of green tea, as the former were with those requisite for black. In 1838 the first twelve chests of tea from Assam were received in England. They had been injured in some degree on the passage, but on samples being submitted to brokers and others of long experience and tried judgment, the reports were highly favourable. It was never, however, the intention of government to carry on the trade: from the first it was proposed to resign it to private adventure, as soon as the experimental course could be considered fairly completed. Mercantile associations for the culture and manufacture of tea in Assam began to be formed as early as 1839, and in 1849 the government disposed of their establishments, relinquishing the pursuit to the ordinary operation of commercial enterprise. In 1851 the crop of the Assam Tea Company was estimated to produce 280,000 lb., and the general aspect of the affairs of that company is described in their latest report as satisfactory and promising.

Vegetable products.

Cultivation of tea.

The climate of Assam is said to be more temperate than that of Bengal, and subject to less variation. The warm weather is moderate, and the nights cool and refreshing. The mean temperature of the four hottest months does not exceed 80°; that of the winter season amounts to 57°, and the mean annual temperature may be stated at 67°. The rains are of unusual duration, commencing in March and continuing till the middle of October. Earthquakes are frequent. No less than twelve are stated to have occurred in the twelve months between May 1834 and May 1835: in 1845 a shock was experienced at Nowgong, whereby considerable damage was sustained.

Geology.

A meagre sketch is all that is possessed of the geology of Assam. The mountains on the opposite sides of the valley are characterized by distinct systems, those on the north being composed of primitive formations, while those on the south partake largely of sandstone, shell-limestone, and coal. Some

Assam.

Minerals.

valuable minerals, however, are met with: gold-dust is found in all the rivers flowing from the northern mountains, but it differs in purity and colour, and also in malleability. That which is obtained in the Dekrungh is particularly celebrated, and is distinguished by a higher colour than that found in the Brahmaputra, though it is more abundant in the bed of the latter river. The greatest quantities of gold are found nearest the mountains, which probably indicates that it is carried down from them by the torrents; but it is never sought in the southern rivers. Beds of iron ore exist in various places, and tracings of former workings to a considerable extent remain; but the native article being undersold by iron imported from England, as well as from adjacent provinces, is by this competition driven out of the market. In noticing the mineral productions, coal must not be overlooked. It has been discovered in beds of considerable magnitude, from the banks of the Noh Dihing in the south-eastern extremity of the province, to the vicinity of the Kossilei River, within 60 miles of Gowhatty; and from the circumstance of its existence at these two extremities, as well as in several intermediate localities, there appear grounds for the inference that the coal formations of Assam are co-extensive with the whole length of the valley. In 1851 specimens of this mineral, derived from the coal-bed of Jaipur, on the Booree Dehing, were forwarded by the Government of India for analysis to Professor Oldham, the superintendent of the geological survey. The professor's report, though not given sufficiently in detail, owing to the condition in which the specimens reached their destination, was still so far encouraging as to induce the belief that the labour of further search would be amply remunerated. Neither copper nor silver are found in Assam. Rock-salt is dug out of the earth, and brine springs are not uncommon in some localities, from the produce of which salt is made; but the manufacture is costly, and the salt is fully as expensive as that imported.

Animals.

The zoology of Assam presents little that is remarkable. Wild elephants abound and commit many depredations, entering villages in large herds, and consuming everything suitable to their tastes. Many are caught by means of female elephants previously tamed, and trained to decoy males into the snares prepared for subjecting them to captivity. A considerable number are tamed and exported from Assam every year, but the speculation appears to be somewhat precarious, as it is said about twice the number exported are annually lost in the course of training. Many are killed every year in the forests for the sake of the ivory which they furnish; and the supply must be very great which can afford so many for export and destruction without any perceptible diminution in their number. The rhinoceros is found in the denser parts of the forests, and generally in swampy places. This animal is hunted and killed for its skin and its horn. The skin affords the material for the best shields. The horn is sacred in the eyes of the natives. Contrary to the usual belief, it is stated that if caught young, the rhinoceros is easily tamed, and becomes strongly attached to his keeper. Tigers abound, and though many are annually destroyed for the sake of the government reward, their numbers seem scarcely at all to diminish. Their destruction is sometimes effected by poisoned arrows discharged from an instrument somewhat resembling a cross bow, in which the arrow is previously fixed, and a string connected with the trigger carried across the path in front of the arrow, and fastened to a peg. The animal thus struck is commonly found dead at the distance of a few yards from the engine prepared for his destruction. Leopards and bears are numerous; and the *Arctonix Collaris* of Cuvier, a small animal somewhat resembling a bear, but having the snout, eyes, and tail of a hog, is found. Among the most formidable animals known is the wild buffalo, which is of great size, strength, and fierceness. Many deaths being caused by this animal, a reward is given for its destruction. The fox and the jackal exist, and the wild hog is very abundant. Goats, deer of various kinds, hares, and two or three species of antelope are found, as are monkeys in great variety. The porcupine, the squirrel, the civet cat, the ichneumon, and the otter are common. The birds are too various to admit of enumeration—wild game is plentiful; pheasants, partridges, snipes, and water fowl of many descriptions furnish attraction for the sportsman. Vultures and some other birds of prey are met with. Crocodiles swarm in all parts of the Brahmaputra. Tortoises are numerous, and constitute a staple article of food sold in the bazaars. Porpesses are common, their favourite resort being the entrance of some tributary stream into the great river. There they are hunted and speared by the natives. Serpents of many kinds exist. Leeches abound; and a land leech is very common in the hills, especially during the rains, when it is found clinging to every bush and blade of grass. It is believed that it might be applied in the exercise of the curative art, as harmlessly as the ordinary medicinal leech, and with similar results. The Brahmaputra abounds with very fine fish in great variety, including the mullet.

Assam.

History and manners of the inhabitants.

The population of Assam is returned at 780,935. The Assamese are descendants of a race called Ahoms, who, about the thirteenth century, emigrated from some more eastern region and possessed themselves of the country; but having no females of their own race, took wives from the aborigines, a circumstance favourable to their stability. Of the religion of the conquerors it seems impossible to speak except in negative terms. It is said to have exhibited no trace of Bhudhism. Its followers were not Hindus, for they ate beef; nor Mahometans, for they were consumers of pork. Other descriptions of animal food, almost universally considered repulsive, entered into their gastronomic repertory, and in this respect they seem to have resembled the Chinese. The Assamese have been described as a degenerate, weakly race; more so, indeed, than the people of Bengal. This, however, is questioned by late observers, who, while admitting the Assamese to be physically inferior to the people of the north-west provinces, regard them as greatly superior to those of Bengal. In complexion they are represented to be somewhat lighter than the Bengalese. Their faces are flat; they have high cheek-bones, and in general physiognomy bear a resemblance to the Chinese. Their hair is black, coarse, and lank. The beard is scanty, and the small quantity bestowed by nature is usually plucked out. The personal characteristics of the women are decidedly superior to those of the other sex. They are fair to a degree not usually met with in India, and many of them, it is said, would in any part of the world be considered beautiful. In most parts of the country they do not affect the personal concealment common in the East, but appear in public as in Europe. The state of morals in both sexes is low. Among the men falsehood and knavery are predominant. They are lazy and utterly careless as to making provision for the future. If compelled to labour, they abandon their work after a day or two, and resort to the more pleasant occupations of drinking arrack and chewing opium. The female part of the population estimate lightly that virtue which is the peculiar ornament of their sex. It is considered a disgrace for a girl to remain unmarried after the attainment of a marriageable age; but, as among the humbler classes this is often unavoidable, the fact of her becoming a mother before she is a wife occasions no scandal, and a parent will bargain for her daughter's honour with as much coolness as if for the sale or hire of a domestic animal. The health of the women is said to be injuriously acted upon by this state of manners and morals. Those who escape the stigma attached to protracted spinsterhood incur the cares and dangers of maternity before the constitution has acquired sufficient strength to sustain them without injury; while those who remain unmarried till a later period of life do not necessarily escape this source of debility, while they are exposed also to the enervating consequences of a career of illicit indulgence. Children are not numerous, and of those born the proportion who die before reaching the second stage of life is large. The darker shades of Assamese life are, however, relieved by a few gleams of light. The respect paid to old age is great. The affection of parents for their children also appears strong, and the bonds of family connection generally are maintained and strengthened by the exercise of kindness. Beyond their own caste, how-

ever, little of good-feeling seems to exist among the people. The Assamese have always been a people of warlike habits; this fact being vouched not only by their original conquest, but by the extension also of the conquered territory. In 1638, during the reign of the Emperor Shah Jehan, the Assamese descended the Brahmaputra and pillaged the country round the city of Dacca; they were expelled by the governor of Bengal, who retaliated upon the plunderers by ravaging Assam. During the civil wars between the sons of Shah Jehan, the king of Assam renewed his predatory incursions into Bengal: upon the termination of the contest, Aurungzebe determined to avenge these repeated insults, and despatched a considerable force for the regular invasion of the Assamese territory. His general, Meer Jumla, defeated the Rajah, who fled to the mountains, and most of the chiefs made their submission to the conqueror. But the rains set in with unusual violence, and Meer Jumla's army was almost annihilated by famine and sickness. Thus terminated the last expedition against Assam by the Mahometans, whose fortunes in this country were never prosperous. A writer of the Mahometan faith says, "Whenever an invading army has entered their territories, the Assamese have sheltered themselves in strong posts, and have distressed the enemy by stratagems, surprises, and alarms, and by cutting off their provisions. If these means failed they have declined a battle in the field, but have carried the peasants into the mountains, burned the grain, and left the country desert. But when the rainy season has set in upon the advancing enemy, they have watched their opportunity to make excursions and vent their rage; the famished invaders have either become their prisoners or been put to death. In this manner powerful and numerous armies have been sunk in that whirlpool of destruction, and not a soul has escaped." The same writer states that the country was spacious, populous, and hard to be penetrated; that it abounded in dangers; that the paths and roads were beset with difficulties; and that the obstacles to conquest were more than could be expressed. The inhabitants, he says, were enterprising, well armed, and always prepared for battle. Moreover they had lofty forts numerously garrisoned and plentifully provided with warlike stores; and the approach to them was opposed by thick and dangerous jungles, and broad and boisterous rivers. The difficulties in the way of successful invasion are of course not extenuated, as it was the object of the writer to exalt the prowess and perseverance of the faithful. He accounts for their temporary success by recording that, "the Mussulman hordes experienced the comfort of fighting for their religion, and the blessings of it reverted to the sovereignty of his just and pious majesty." The short-lived triumph of the Mussulmans might, however, have warranted a less ambitious tone. About the middle of the seventeenth century the chief became a convert to Hinduism. By what mode the conversion was effected does not clearly appear, but whatever were the means employed it seems that the decline of the country commenced about the same period. Internal dissensions, invasion, and disturbances of every kind convulsed the province, and neither prince nor people enjoyed security. Late in the eighteenth century some interference took place on the part of the British government, then conducted by Lord Cornwallis; but the successor of that nobleman, Sir John Shore, adopting the non-intervention policy, withdrew the British force, and abandoned the country to its fate. Its condition encouraged the Burmese, an aggressive people, to depose the Rajah and to make Assam a dependency of Ava. The extension of their encroachments on a portion of the territory of the East India Company compelled the British Government to take decisive steps for its own protection. Hence arose the series of hostilities with Ava, known in Indian history as the first Burmese war, on the termination of which by treaty in February 1826, Assam remained a British possession. In 1833 that portion of the province denominated Upper Assam, was formed into an independent native state, and conferred upon Poorunder Sing, the ex-Rajah of the country; but the administration of this chief proved unsatisfactory, and in 1838 his principality was reunited with the British dominions. (E. T.)

ASSARIUM, in *Antiquity*, denotes a small copper coin, being a part or diminutive of the *as*. The word ἀσσάριον is used by Suidas indifferently with ὀβολός and νόμισμα, to denote a small piece of money; but according to Polybius (ii. 15), the assarium was equal to half the ὀβολός, or $3\frac{1}{4}$ farthings. We find mention of the assarium in the gospel of St Matthew, chap. x. ver. 29.

ASSASSIN, a person who kills another with the advantage either of an inequality in the weapons, or by means of the situation of the place, or by attacking him unawares. The word *assassin* is said by some to have been introduced from the Levant, where it took its rise from a certain prince of the family of the *Arsacidæ*, popularly called *Assassins*, living in a castle between Antioch and Damascus, and bringing up a number of young men, ready to pay a blind obedience to his commands; whom he employed in murdering the princes with whom he was at enmity. This people probably owed their origin to the Carmatians, a famous heretical sect among the Mahometans, who settled in Persia about the year 1090; whence, in process of time, they sent a colony into Syria, where they became possessed of a considerable tract of land among the mountains of Lebanon, extending itself from the neighbourhood of Antioch to Damascus. According to Colonel Chesney, the Assassins, or Ismaïli, have their chief seat still at Kalat-el-Masryad in Persia; and they have several strongholds in the mountains of Tripoli. Their name is most probably derived from the intoxicating plant *Cannabis indica*, which they use, and which is called *Hacchisshin* in Persic; "and has no connection with the *Old Man of the Mountain*." The first chief and legislator of this remarkable tribe appears to have been Hassan Ben Sabah, a subtle impostor, who by his artifices made fanatical and implicit slaves of his subjects. Their religion was compounded of that of the Magi, the Jews, the Christians, and the Mahometans; but the capital article of their creed was to believe that the Holy Ghost resided in their chief; that his orders proceeded from God himself, and were real declarations of his divine pleasure. To this monarch the orientals gave the name of *Sheikh-el-Jebelz;* but he is better known in Europe by the name of the *Old Man of the Mountain.* This chief, from his residence on Mount Lebanon, like a vindictive deity, with the thunderbolt in his hand, sent inevitable death to all quarters of the world; so that from one end of the earth to the other, caliphs, emperors, sultans, kings, princes, Christians, Mahometans, and Jews, every nation and people, execrated and dreaded his sanguinary power, from the strokes of which there was no security. At the least suggestion or whisper that he had threatened the death of any potentate, all immediately doubled their guards, and took every other precaution in their power. It is known that Philip Augustus, king of France, on a premature advice that the sheikh intended to have him assassinated, instituted a new body-guard of men distinguished for their activity and courage, called *sergens d'armes*, with brass clubs, and bows and arrows; and he himself never appeared without a club, fortified either with iron or gold. Most sovereigns paid secretly a pension to the sheikh, however scandalous and derogatory it might be to the lustre of majesty, for the safety of their persons. The knights-templars alone dared to defy his secret machinations and open force. This people once had, or at least they feigned to have, an intention of embracing the Christian religion. They reigned a long time in Persia and on Mount Lebanon. Holagoo or Hu-

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laku, a leader of the Mogul Tartars, in the year 655 of the Hegira, or 1254 of the Christian era, entered their country and dispossessed them of several places; but it was not till some years after that they were totally extirpated. This achievement was owing to the conduct and intrepidity of the Egyptian forces sent against them by the Sultan Bibars.

A *History of the Assassins*, in the German language, by Mr Von Hammer, was published at Stuttgard in 1818. It contains some new and striking views of the origin, proceedings, and doctrines of the sect. He represents them as forming a military and religious order, subject to the control and direction of a grand master, like the templars, to whom the title of Old Man of the Mountain was applied. This learned and curious work has been translated into English by Mr Wood.

ASSAULT, in *English Law*, is an offer or attempt to hurt the person of another; as, if one lift up his cane or his fist in a threatening manner at another, or strike at him, but miss him, this is an assault; the actual touching of the person not being necessary to make the offence. Finch describes it to be "an unlawful setting upon one's person." No words whatsoever, be they ever so provoking, can amount to an assault. There are, however, opinions to the contrary.

ASSAY, Essay, or Say, in *Metallurgy*, the proof or trial of the goodness, purity, value, &c., of metals and metalline substances. In ancient statutes this is called *touch*, and those who had the care of it *keepers of the touch*.

ASSAYING, taken in its general acceptation, is a chemical process by which any ore, or other metallic compound, is analysed, and its constituent parts determined. But the term more particularly denotes the peculiar art by which gold and silver are examined, and their qualities ascertained, in relation to their state of purity. By the former the whole contents of the substance under examination are separated and collected; by the latter it is only necessary in practice to find, by the destruction or separation of the alloys, the amount of pure metal contained in the specimen operated on, so that a value may be given, by computation, to the whole mass. To this specific branch we purpose to confine ourselves in the following observations.

Importance of this art.

The art of assaying the precious metals must be esteemed of considerable importance in many points of view; but more especially to commercial nations trading extensively in these commodities. For although the ultimate destination of these metals be their conversion into coin, plate, or other articles of use and ornament, still there are vast treasures of bullion consigned to the stores of different countries merely as commodities, as convenient representatives of value, or in security for nominal wealth, the marketable value of which is determined solely by the skill and accuracy of the assayer. Every one having experience of such matters knows that, unlike other things of a mercantile nature, bullion cannot be valued by its bulk, weight, or any simple external characteristic, but by ascertaining in some way the amount of fine metal contained in a given quantity. And implicit confidence being placed in the honesty, accuracy, and fidelity of the assayer, who, by examining a small portion only, gives a certificate of its quality upon which the whole is estimated, merchants are enabled to buy and sell bullion without risk of loss, and with the most perfect assurance of the value being maintained. By means of the art of assaying, as applicable to small as to large things, we also possess a certain safeguard against fraud in the manufacture of plate and other articles of personal or domestic use, which must be regarded as of some importance in a country rich and affluent like Great Britain, where gold and silver have become so common amongst the middle classes as scarcely to be esteemed luxuries. We could only wish that the laws which prevail in reference to plate were more generally extended in their application to the manufacture of jewellery, and other personal ornaments; for in these things the public have no guarantee against fraud and knavery beyond the character or assurance of the dealer.

If the art of assaying be deemed valuable and important as regards bullion and plate, securing a certain and reliable test of value, as well as a sufficient check upon fraudulent designs, we cannot surely question its even greater importance in reference to the metallic currency of a country, the standard accuracy of which affects materially the interests of all, and so far tends to promote the welfare of mankind. Whatever this standard be, it is obvious the value of all property in exchange must be regulated and determined by it, whether in land, houses, commodities, or the wages of labour; and if we had no reliance on the integrity of our coin, as a measure of value, we could enjoy no security in our property. In all countries, therefore, claiming a character for honesty, the integrity of the standard should be a fundamental principle. Any, the slightest, deviation from it, will instantly be discovered, followed by a loss of credit, and violent fluctuations in the exchange, which of all things are most injurious to trading communities. For the exchange between one country and another is not determined by coin merely as a circulating medium, but, in reality, by the exact amount of fine metal contained in the coin; and, therefore, it is necessary to know that the proportion is maintained called *the standard*, which, in our gold currency, consists of eleven-twelfths of pure metal and one-twelfth of alloy. This fact can only be ascertained by the process of assay. But when nations acquire a character for honesty and integrity, the currency will freely circulate all over the world without suspicion, at its reputed value, and the currency of one be easily converted into the currency of another. But we should fail to secure this great advantage, this implicit confidence, without the assayer's skill and check, by which the due proportions of metal are guaranteed, and any depreciation detected.

We need now no longer apprehend any of those capricious and dishonourable changes in the currency, not unknown to our history before the reign of Elizabeth, which enriched the monarch at the expense of his subjects, created sudden and violent changes in the value of property, and often spread dismay and poverty amongst all classes, without any clear knowledge of the cause. That patriotic and sagacious queen, of whom England is justly proud, among other great and durable merits, is honourably distinguished by the restoration of our currency to purity, and by fixing our present standard of value, from which, happily, no deviation can be notified in succeeding ages. In this respect science and knowledge, if not always the handmaids of integrity, are the best guarantees against fraud and evil designs; and we can scarcely believe it possible, in these times, to suffer from a dishonourable depreciation of the currency, while any vague apprehension of error is instantly dissipated by the numerous checks, public and private, on the purity of our coin. Amongst these we may briefly instance the ancient ceremony called the *Trial of the Pyx*, which, in the most public manner, secures an impartial examination of the coinage, and a verdict, as public, of its legal or standard purity. In no other country have we been able to discover an institution analogous to this, which, after all intermediate tests have been tried in the process of manufacture, affords an ultimate and judicial appeal for the public satisfaction. And it may be added, to the credit of the officers of the Mint, that, whatever may happen in future times, amid the sudden and hasty revolutions in public affairs, during the past we are unable to adduce any instance of this ordeal being passed without honour and integrity; and instead of the allowance or remedy by law for errors, unavoidable in manufacture, being taken advantage of, as a protec-

Trial of the Pyx

tion to carelessness, we may pronounce that the coinage has always been proved to be as nigh to the legal standard as is possible, the deviation being on the average scarcely worth notification.

The *Trial of the Pyx* takes place once in about every three years, but no specified period is fixed by law. It is so denominated from the pyx, or chest, in which the specimen coins are deposited in the Mint for future examination; these specimen coins being supposed a fair representation of the whole money coined within a certain period. Out of each bag of coin, whether gold or silver, two pieces are taken, one for the trial by assay within the Mint, the other for the general pyx; and these are carefully sealed up in paper by three officers, and deposited in the chest. It should be remarked, that previously to the issue of coin to the public, a minor pyx takes place within the Mint, intended for the examination of the coined money by appointed officers, as regards both weight and fineness, and no coin is permitted to be delivered before it has passed this necessary ordeal.

It having been notified to the government that a trial of the pyx is called for, the Lord Chancellor issues his warrant to summon a jury of goldsmiths, who, on the appointed day, proceed to the Exchequer Office, Whitehall, and there, in presence of several privy-councillors, and the officers of the Mint, receive the solemn charge of the Lord Chancellor, who directs them in their important functions, and requests them to deliver to him a verdict of their finding. A piece of gold and silver, cut from the *trial-plates* deposited in the Exchequer, supposed to be of the exact legal standard, are delivered to the foreman of the jury, who is required to declare to what degree the coin under examination deviates from them. This being done, the jury proceed to Goldsmith's Hall, London, where assaying apparatus, and all other necessary appliances, are in daily use for the trial of gold and silver plate; and sealed packets of the specimen coins being delivered to them by the officers of the Mint, they are first tried by weight, and then a certain number are taken from the whole and melted into a bar, from which the assay trials are subsequently taken.

The verdict of the jury, founded on the results of these proceedings, proving favourable, the Master of the Mint and subordinate officers are released from all further responsibility, while the country receives, by the publicity of the verdict, an attestation of the standard purity of the coinage.

In times of comparative ignorance, the art of assaying was esteemed a mystery, and, like some other crafts, the practice of it was retained in few hands. There were supposed secrets in the conduct of the processes which none but the initiated were permitted to know; but now it is admitted that those secrets are nothing but the knowledge acquired by long experience, amounting in reality to certain allowances or adjustments in the results of the operations. The uncertain tests and appliances employed in ancient times, which afforded only a wide approximation to truth, and exposed the public to extortion and fraud, have in more scientific times been superseded by chemical processes as accurate as they are delicate and beautiful. The exquisite and varied laws of nature, in connection with metals and their transformations, are made instrumental to the use and knowledge of mankind; and science, so called, enables man to nicely balance and estimate the vast treasures found in the bowels of the earth, and constitute them measures of value more unchanging than any other product of nature. As science has progressed, so has the art of assaying improved, while in modern times new fields have been opened up for its use and application. Along with increased accuracy, it has become more varied and extensive in its practice. The amount of the precious metals have not only increased immeasurably, thereby magnifying the importance of the art, but in recent times changes in the mode of refining or separating these metals have created a new branch of business little practised in former ages. The application of sulphuric acid to separate gold from silver, and silver from gold, by which the operation is effected with great economy, and nearly all the contents recovered at comparatively little cost, has led to an extensive business in *parting* assays, which did not formerly exist. In this manner the holder of bullion, of a mixed character, has a higher value put upon his metal by reason of the gold or silver contained in it; and in the market he is able to realize the whole value by assay, less the deduction made to cover the charge of refining. The *parting* assay is different from the simple assay in this, that it declares upon the certificate of a gold assay the amount of silver combined with it, and of a silver assay the number of grains of fine gold contained in each pound.

The bullion to be valued having been melted into ingots or bars, small pieces are cut from each and folded separately in slips of paper with a corresponding mark or number of the bar, so as to preserve the identification of the assay reports with the bars. On these slips of paper the assayer writes his report, which declares the quality of the gold and silver, and this is the certificate upon which the bullion is bought and sold in the market. The Bank of England, however, and the Mint, in order to guard against any surreptitious change, or fraud, require the assays upon which they receive bullion to be cut off in presence of appointed officers. The assayer reports gold by *carats,* and silver by pennyweights. In the one case the Troy pound is divided into 24 parts or carats, and British standard being $\frac{11}{12}$ths fine gold and $\frac{1}{12}$th alloy, the carat will thus represent 10 dwts. Troy, the standard being therefore 22 carats fine and 2 carats alloy. In the other the Troy pound is divided into 240 dwts., and the standard of silver being 222 dwts. fine and 18 dwts. of alloy, the pennyweight will represent the $\frac{1}{240}$th of the pound.

Assay weights and reports.

Carats are subdivided into four carat grains, = 60 Troy grains each, and these are again further subdivided into eighths of a carat grain, = $7\frac{1}{2}$ grains Troy. The lowest trade report of gold is one-eighth of a carat grain, and of silver, half a pennyweight. In reporting gold, the practice in general use is to take 2 carats as the representative of fine gold for bullion *better* than standard, and 24 carats for bullion *worse* than standard. Thus a bar reported *better* 1. $3\frac{3}{4}$, or one carat, three carat grains, and three-quarters of a grain, is within one-quarter of a carat grain of purity, or 15 grains Troy. But if a bar were found to contain only one-half of fine gold, the report would not be one carat worse, but *worse* 12 carats, or $\frac{12}{24}$ths. We may observe, however, that this complex mode of enumeration, so great a mystery to the uninitiated, will probably in a few years be entirely superseded by the decimal system of notation in general use on the continent. Already it is partially adopted by assayers in England, who are now required to append the decimal report, to the ordinary one, on the certificate. Instead of carats and pennyweights, the numeral 1000 will represent fine gold and silver, and any deviation in purity from this will be expressed by a decimal instead of a vulgar fraction.

It has been already remarked that the lowest denomination of the trade report is $\frac{1}{8}$th of a carat grain, or $7\frac{1}{2}$ grains Troy, as respects gold, and half a pennyweight, or 12 grains, as respects silver; but practically an assayer can arrive at a much nearer approximation to the truth. As in the Royal Mint, in making the combination for standard coin, he can report to a single grain, or $\frac{1}{5760}$th, in each case; but in buying and selling bullion some protection to the purchaser is deemed necessary as an indemnity against errors and irre-

Assaying.

gular mixture of the alloy, and hence arises the above latitude in the assay report. It is probable, however, that the general use of decimal notation will eventually cause a more accurate report, and deprive the bullion dealer of a share of that advantage which obviously is greater than is necessary.

An ordinary assay report of gold and silver expresses the variation from the standard, and not the fine metal contained in it; and it is, therefore, marked as either better or worse than standard. The standard of gold being 22 carats fine and 2 alloy, or $\frac{11}{12}$ths fine, an ingot of gold found to contain only 21 carats pure gold would be reported *worse* 1 carat; if it contained $23\frac{1}{2}$ carats, it would then be reported *better* 1 carat, 3 grains, and half a grain. The standard of silver being 11 oz. 2 dwts. fine, and 18 dwts. alloy, an ingot of silver found to contain only 11 oz. of fine would be reported *worse* 2 dwts., but if it contained 11 oz. $4\frac{1}{2}$, the report would then be *better* $2\frac{1}{2}$ dwts.

In buying or selling, the *betterness* or *worseness* of the bar is added or deducted from the gross weight; and the value is computed on this, the standard weight, at the market price of the day.

When the assay required is a *parting* assay, or an assay of gold containing silver, a report is given of the weight of fine silver in the pound; and when the silver exceeds 15 dwts. per pound, all above that is usually added to the value of the gold, that being an allowance made by general agreement for the cost of separation or refining. So likewise with an assay of silver holding gold. The report declares the number of grains of fine gold in the pound, and all above 3 or 4 grains is added to the computed value of the silver.

In these delicate operations we need scarcely impress upon the reader how important an instrument an accurate balance must be in securing a certain and uniform result. The specimen taken by an assayer is no more than 12 or 15 grains of the mass, and if 12 grains, each grain would represent an ounce, or $\frac{1}{480}$th. In the Royal Mint, the fine balances in use are sensible to the $\frac{1}{1000}$th of a grain.

The principle of assaying gold and silver is very simple theoretically, but in practice great experience is necessary to insure accuracy; and there is no branch of business which demands more personal and undivided attention. The result is liable to the influence of so many contingencies, that no assayer who regards his reputation will delegate the principal processes to one not equally skilled with himself. Besides the result ascertainable by weight, there are allowances and compensations to be made which are known only to an experienced assayer, and if these were disregarded, as might be the case with the mere novice, the report would be wide from the truth.

With regard to silver assaying, the chief principles in the process are—1. The power of lead to oxidate, or destroy the metallic property of the alloys, which it does by combining with them and sublimating them in fumes; 2. The absorbing power of the cupels in which the assays are made, and by which a great portion of the lead is taken up.

With regard to gold assaying, the same principles prevail in the preliminary process of cupellation, the result being a compound of gold and silver in their pure state. In the second process of *parting* the two metals, the first principle is the property of nitric acid to bring silver into a state of solution while it leaves gold untouched. The silver thus separated from the gold, which remains in a pure state, enters not into the calculation unless a parting assay is required, and therefore it is not recovered for any purpose connected with the art.

But before proceeding to the detailed description of the various delicate and interesting processes comprised in the art of assaying, we shall first describe the furnaces and implements formerly in use, as well as those changes and improvements which have been recently introduced and adopted, the result of experience and the promptings of scientific research, by which it may be said assaying has approached as near to certainty as can be expected in any chemical operation.

Assaying.

Description of furnaces, &c., formerly in use.

Plate LXXIV., A A A A, fig. 1, is a front elevation of an assay furnace; *a a*, a view of one of the two iron rollers on which the furnace rests, and by means of which it is moved forward or backward; *b*, the ash-pit; *c c* are the ash-pit dampers, which are moved in a horizontal direction towards each other for regulating the draught of the furnace; *d*, the door or opening by which the cupels and assays are introduced into the muffle; *e*, a movable funnel or chimney, by which the draught of the furnace is increased.

B B B B, fig. 2, a perpendicular section of fig. 1; *a a*, end view of the rollers; *b*, the ash-pit; *c*, one of the ash-pit dampers; *d*, the grate; *e*, the plate upon which the muffle rests, and which is covered with loam nearly one inch thick; *f*, the muffle in section representing the situation of the cupels; *g*, the mouth plate, and upon it are laid pieces of charcoal, which, during the process, are ignited, and heat the air that is allowed to pass over the cupels, and which will be more fully explained in the sequel; *h*, the interior of the furnace, exhibiting the fuel.

The total height of this furnace is 2 feet $6\frac{1}{2}$ inches; from the bottom to the grate 6 inches; the grate, muffle, plate, and bed of loam with which it is covered, 3 inches; from the upper surface of the grate to the commencement of the funnel, *e*, fig. 1, $21\frac{1}{2}$ inches; the funnel *e* 6 inches. The square of the furnace which receives the muffle and fuel is $11\frac{3}{4}$ inches by 15 inches. The external sides of the furnace are made of plates of wrought iron, and are lined with a 2-inch fire-brick.

C C C C, fig. 3, is a horizontal section of the furnace over the grate, showing the width of the mouth-piece or plate of wrought iron, which is 6 inches, and the opening which receives the muffle-plate.

Fig. 4 represents the muffle or pot, which is 12 inches long, 6 inches broad inside; in the clear $6\frac{3}{4}$; in height $4\frac{1}{2}$ inside measure, and nearly $5\frac{1}{2}$ in the clear.

Fig. 5, the muffle-plate, and which is of the same size as the bottom of the muffle.

Fig. 6 is a representation of the sliding door of the mouth-plate, as shown at *d* in fig. 1.

Fig. 7, a front view of the mouth-plate or piece, *d*, fig. 1.

Fig. 8, a representation of the mode of making, or shutting up with pieces of charcoal, the mouth of the furnace.

Fig. 9, a view of the cupel, which is generally 1 inch by $\frac{7}{8}$ths of an inch.

Fig. 10, the teaser for cleaning the grate.

Fig. 11, a larger teaser, which is introduced at the top of the furnace, for keeping a complete supply of charcoal around the muffle.

Fig. 12, the tongs used for charging the assays into the cupels.

Fig. 13 represents a board of wood used as a register, and is divided into 45 equal compartments, upon which the assays are placed previous to their being introduced into the furnace. When the operation is performed, the cupels are placed in the furnace in situations corresponding to these assays on the board. By these means all confusion is avoided, and without this regularity it would be impossible to preserve the accuracy which the delicate operations of the assayer require.

Figs. 14, 15, 16, 17, represent sections of a smaller assay furnace invented by MM. Anfrye and D'Arcet of Paris, called by them *Le petit fourneau à coupelle*, and which may be advantageously used by the experimental assayer. It is composed of a chimney or pipe of wrought iron *a*, and of the furnace B. It is $17\frac{1}{2}$ inches high, and $7\frac{1}{4}$ inches wide. The furnace is formed of three pieces; of a dome A; the body of the furnace B; and the ash-pit C, which is used as the base of the furnace, figs. 14 and 15. The principal piece or body of the furnace has the form of a hollow cylinder, flattened equally at the two opposite sides, parallel to the axis, and in such a manner that the horizontal section is elliptical.

The section of the furnace, fig. 15, presents several openings; the principal, which is that of the muffle, is placed in *i*; it is shut with the semicircular door *m*, fig. 14, and as is seen in the section *m*, fig. 15. In front of this opening is the table or shelf upon which the door of the muffle is made to advance or recede; the letter *q*, fig. 15, shows the face, side, and cross section of the shelf, which makes part of the furnace.

Fig. 19 is a plan of the grate of the furnace; and fig. 20 a horizontal view of it.

Figs. 21, 22, 23, are views of the muffle.

Fig. 24 is a view of a crucible for annealing gold.

Figs. 25, 26, 27, are cupels of various sizes, to be used in the furnace.

Assaying.

Figs. 28 and 29 are views of the hand-shovels used for filling the furnace with charcoal.

Fig. 30, the smaller pincers or tongs by which the assays are charged into the cupels.

Fig. 18, the teaser for cleaning the grate of the furnace.

Fig. 16 is a representation of the furnace first constructed by MM. Anfrye and D'Arcet, and which was worked by means of a pair of bellows, which forced a current of air through the brass tube *b*, entering the ash-pit under the grate at the circular hole *c*, fig. 15. The strength of the blast or current of air can be regulated at pleasure by the stop-cock *d*, fig. 16.

As the accuracy of the art of assaying depends in a great measure upon the construction of the furnace, as well as its management, and other implements and appliances, we proceed now to describe the improvements introduced recently in the Royal Mint by Mr H. W. Field, the Resident Assay-master of that establishment, which tend to secure greater accuracy, and allow of the processes to be conducted with greater economy. Instead of the expensive product, charcoal, being used in the cupellation-furnace, anthracite coal has been substituted; and the old sand-bath, employed to boil the acid, has been superseded by the use of gas.

In the furnace already described, figs. 1 and 2, the usual mode of lighting and feeding it is to throw the charcoal in at the top, igniting the fuel by means of a faggot of wood placed on the charcoal. In this manner two to three hours are necessary to raise the furnace to the required temperature to carry on the process.

In the new furnace, Plate LXXV, figs. 32 and 33, the fuel is ignited by a small quantity of live charcoal scattered round the sides and end of the muffle; and a few minutes having elapsed, the furnace is then filled up to the door, *h*, with anthracite coal, broken into fragments of about the size of a two-inch cube, and perfectly free from dust. The doors of the furnace should then be closed, excepting that of the ash-pit, and damper in the chimney, intended to give circulation to the air.

When the coal is found to be in a state of combustion, either the door at the top, *x*, or the furnace door, *h*, or both, should be opened, as experience may dictate; because it must be borne in mind that, after a certain point, if the heat were urged too suddenly, either the muffle would crack and be spoilt, or the bottom be too hot and the roof too cold, while at the same time clinkers formed in the furnace might impede the draught. If these simple precautions are attended to, and the heat gradually raised, the annealing of the muffle, cupels, and furnace will be uniform, and both trouble and expense avoided. By the use of anthracite coal, the process of cupellation may be carried on as successfully as by charcoal, when a saving is made of 550 per cent.

Description of new anthracite furnace.

Plate LXXV., fig. 32, is the front elevation of Mr Field's furnace; *a*, a view of the front iron-roller, on which it rests; *b*, the ash-pit; *c c* are the dampers moving horizontally from side to side towards each other, meeting exactly in the centre; *d*, the muffle-door by which the assays are introduced; *e e*, the door slides. So far the body of the furnace is similar to the old one, except that the bars on which the muffle stands run from front to back, and are movable, rendering the removal of the brick-work unnecessary. By this means the muffle stand is easily introduced, and having steady pins on the under side, it is raised about an inch above the bars.

The furnace measures 2 feet 10 inches in height; 1 foot 7 inches in width; and 1 foot 11 inches in depth. Instead of the furnace, as formerly, being fed at the top, the fuel is charged by the door *h*, which also affords the means of regulating the draught, and of throwing a current of air through the muffle by the door *d*. This door has a bar, *k*, traversing about two-thirds of it, running easily from the top towards the bottom within *i i*, with a ketch, *m*, on each side, to keep it close. These are made on an incline, and about 3½ inches long, so as to allow the traversing-bar to slide freely when the door is not required to be closed. In this manner the door may be opened from a quarter of an inch to the extent of three inches.

This feeding and regulating door is fixed by hinges, *l l*, to the front part of the *iron frame* covering the brick lining on the top of the furnace. On this frame rests the square dome, the front of which, *w*, is removable by two handles, *n n*; and by taking out the two thumb-screws, *o o*, the door and part of the frame come away, leaving a large opening, so as to enable the furnace to be cleared, the muffle repaired, &c.

The furnace should be placed in a recess under a chimney, with a movable iron ceiling, *t*, about one foot above the dome, fitting close in every part, so that the draught of air may pass through the furnace. A door, or flap, *x*, is attached to the iron ceiling by a hinge, opening on the side of the recess, with means to fix it at any point required, so that the current of air may be regulated by the operator: *s*, a swivel door affords another mode for damping the furnace.

Fig. 33 is a section of the furnace fig. 32: *a a*, the two rollers on which the furnace is placed; *b b*, the slides on which the ash-pit doors run; *c*, the door and ash-pit; *d*, the iron casing to the furnace; *e*, the brick lining; *f*, the ash-pit; *g g*, the two bars inserted in the brick lining, one in front, one at the back, support the furnace bars, which can easily be removed at pleasure; *h* shows one of the bars on which the muffle-plate rests; *i*, a movable tray on which the mouth coal is placed; *k* is a section of a muffle charged with its full complement of 50 cupels; showing also the rows of holes over each row of cupels, through which a current of air passes. Similar holes are placed at the back in three rows. They are not pierced through horizontally, but slope towards the ceiling of the muffle, at such an angle as to exclude the ashes; *l* represents the extra covering of fire-clay; *m*, the anthracite coal, showing the level; *n*, the feeding and regulating door; *o*, the ketch, or inclined plane on which the sliding bar travels; *p*, the door, with running staples in which the bar slides; *q*, the mode in which the movable front is brought round, and fixed by thumb-screws, *r*; *s v*, the hood; *t*, handle for removing the front; *w x*, the damper and handle; *y*, the iron ceiling.

Fig. 34 represents the upper internal view of the furnace bars, with the muffle stand or plate, showing also the space intended for the fuel.

Fig. 35 is the mouth of the muffle door, representing the mode of regulating the current of air by cylinders of charcoal. Fig 40 is the movable muffle door.

Fig. 38 is a representation of a muffle, 14½ inches long, 7½ inches wide, until it begins to taper at about 1½ inches from the front (see fig. 39), when it does not exceed 5½ inches. The height is 6½ inches, in the clear 5⅝ inches. Its sides are perforated with holes about a quarter of an inch diameter.

Fig. 36, an annealing-iron for softening the assays after they are flattened and rolled. It resembles a square box of iron about ⅛th of an inch thick, having strengthening pieces rivetted at each end, and two in the middle, *b b b' b b*, between which are receiving places for the assays, *a a a*. The apertures are made diagonally, as shown by *c c c*, that the assays may not fall completely to the bottom of the box, so that they may be conveniently removed. The under part of the box has a kind of double keel, *d*, rivetted on it, so that in taking it from the furnace there be no danger of upsetting it on the *nealing trident*.

Fig. 37 represents the trident for removing the annealing-iron from the furnace.

Gas apparatus.

Fig. 41 is a view of the apparatus for boiling the gold assays in acid. Though, it may be remarked, there is no peculiar novelty in boiling by the agency of gas, this is a very useful and ingenious application of the principle; and, we may add, that the apparatus here represented, constructed by the Assay-master of the Royal Mint, is superior to any in use. By it 45 gold assays can be operated upon at the same time, but its greatest advantage is the perfect control which it gives to the assayer over the process, by which great uniformity in the result is obtained.

The whole apparatus, with the exception of the wooden feet and slips upon which the flasks rest, is constructed of brass, and consists of three tubes, *b b b*, firmly fixed at each end to two sides of mahogany, *a a*, by screws: each tube has a cap *h* soldered thereon, with small stopcock; the other end is open, in order to secure its connection, by a vulcanized india-rubber tube, with three fixed pipes having stop-cocks; and these pipes again unite in one main pipe, also furnished with a cock.

From the end of the front and back tubes or bars, *b b*, rise the metal pillars *g g g g*, to which are attached the inclined supports *k k* on each side, having notches for the movable bars *f f f*, which are so arranged as to allow the operator to see over each bar the row of burners behind it, as well as inspect the ebullition of the liquid. From the three tubes or bars *b b b* rise the gas-burners, *c d e*, each row being fixed at a distance sufficient to allow the flasks when resting over the burners and against the movable bar to be secure from falling. The burners have each a separate stop-cock, and as the tubes, or bars, are arranged at different heights, the highest being in front, the operator can easily reach the stop-cock of any particular burner, or, if necessary, a key can be applied.

Assaying.

The movable bars *f f f* have cross handles at each end to remove them, and on the front of the bars a piece of wood is screwed, having semi-circular notches exactly opposite each burner in which the neck of the flask rests, while the body of the flask is supported over the burner by brass rings passing through the bar above, attached and fixed by thumb or milled screws, thus affording the means of adjustment as to distance from the burner, &c. These particulars may be seen by a reference to fig. 42, *a b c d*.

Fig. 43 is a section of the apparatus; *a*, the wooden stand; *b b b*, the three tubes or bars by which the gas passes to the several burners; *g g*, the pillars, rising from the front and back bars, which at *h h* hold the sloping notched supports *k*, for the movable bars *f*; *c, e*, faintly indicate the burners; *d*, the middle line of burners, showing also the stop-cocks, with the rings supporting the flasks over the flame; *m m*, the notches for front and back movable bars; *f*, the handle to the bar to which the ring supports are fixed by screws.

Fig. 44, a tray for the flasks when charging the acid, or washing the assay.

Fig. 45, tray to stand in front of the operator in case one or more flasks require to be removed before the whole are sufficiently boiled.

Fig. 46 represents a stand for holding the movable bars when taken from the apparatus to charge the acids or otherwise.

Fig. 47 shews a burner unscrewed from the bar.

Fig. 48, the wire support.

Fig. 42, a portion of a movable bar; *a*, a burner; *b*, part of supporting bar; *c*, a flask; *d*, rings for carrying flasks.

Fig. 49, a glass-lipped vessel in which the acid is placed before filling the flasks. *b*, a *pipette* by which an equal quantity of acid is supplied to each flask.

By this description, the mode of working may be easily seen. The movable bars are first charged with the flasks containing acid. The three small cocks *h h h*, at the end of the tubes, are then opened, for speedy escape of the air; next the main or chief cock; and then the other three cocks communicating with the tubes. Each individual burner can be regulated by its own stop-cock, the whole tube by its cock, and the whole apparatus by the main.

Having thus fully described the various implements in use amongst assayers, without which the process could not be conducted with any practical utility, it is necessary to make some preliminary observations here with regard to the lead, cupels, &c., before the operation of the assay commences. The cupels are made of the ashes of calcined bones, or phosphate of lime, and besides being uninjured by the ordinary heat of an assay furnace, they possess the peculiar property of absorbing the lead used to refine the silver. Hence the term *cupellation* applied to the process of purifying gold and silver by fire on cupels.

The cupels are formed in a circular mould made of forged steel, nicely turned, by which means they are easily freed from the mould when struck. The bone-ash being moistened with a quantity of water, just sufficient to make the particles adhere, is put into the mould and pressed down level with the surface. It is then struck with a pestle or rammer, smoothly turned and polished, the end being of a convex shape, and of the exact size of the cupel required. (See Plate LXXV., figs. 50 and 51, the section.) This concavity forms the cup in which the assay is made. These cupels are allowed to dry in the air for some time before they are used, and are annealed in the furnace before the assay is charged in.

The lead used in cupellation should be of the greatest purity, because, as most lead contains a small portion of silver, this silver would necessarily combine with the assay, and vitiate the accuracy of the result. Lead revived from litharge is supposed to be the purest, as it contains scarcely any silver. Another important consideration in the process of assaying is the *quantity* of lead to be used with each assay, but such information can only be acquired by experience; for the assayer must first ascertain the approximate quality of the metal to be examined before he can determine the amount of lead necessary.

This in ancient times was effected by the use of what were called *touch-needles*, or slips of metal composed of pure silver alloyed with definite proportions of copper in a regularly-increasing series. The silver to be assayed was examined in comparison with these touch-needles in colour, tenacity, and other external characters, and its alloy was estimated by that of the needle to which it showed the closest resemblance. These needles are now seldom used, the assayer relying on his general experience for the quality of the metal. Having ascertained this point so far as is necessary, he apportions the lead deemed requisite (ranging from 10 to 20 times the weight of silver), which is first flattened into a thin plate from small bullets cast for this purpose.

Assaying.

Silver assaying.

We will now proceed to describe and explain the process of assaying silver by cupellation.

The small specimen of silver sent to an assayer cut from the bar to be valued, usually weighs from 3 to 4 dwts.: it is folded in a slip of paper on the head of which is written the date, the mark or number of the bar from which it was severed, and the kind of assay required. This piece is flattened upon a polished anvil by means of a hammer, which should be examined and freed not only from dirt but from any particles of metal flatted from previous assays. From the silver, thus flattened to about the $\frac{1}{25}$th of an inch thick, the centre portion is cut out, as being the most compact, and is then adjusted in a "preparing balance," by cutting and filing to the weight of what is technically denominated the "assay pound." After this preliminary weighing, it is then weighed most accurately in one of the superior balances.

At this stage of the operation it is necessary to ascertain the approximation to purity of the metal, so that the proper amount of lead be added; but, as we have before remarked, practice alone can guide the assayer in this particular. The chief indications relied on are the specific gravity, colour, and even sound; for the purer the silver is the less it rings, while at the same time whiteness, softness, ductility, and superior gravity are tokens of purity; but, on the contrary, when sonorous, yellow, and specifically light, it may be inferred that the metal is base in the degree that these peculiarities are indicated.

The amount of lead having been determined, the assay is wrapped up in a known quantity (say one-half of that required for its purification), formed into a case somewhat resembling a thimble, great care being taken to make the joints firm and close, so that no particle of silver shall escape. When a number of assays are made at the same time, they are arranged, enveloped in their cases of lead, on a board divided into compartments, corresponding in number and position with the cupels into which they are intended to be charged. As the assayer makes generally two or more trials of the same piece, so that great accuracy may be secured, it is his practice to give one assay a side place in the muffle, and the second a middle one, in order to check any irregularity in the result.

When a sufficient number of assays are weighed, and arranged upon the board, in the manner referred to, and the furnace raised to the necessary point of heat as well as the cupels, the charging tongs are then taken, and the *rest* of the lead apportioned to each assay placed individually upon the cupels, beginning at the back of the muffle. The lead added in this case is not flattened, but a piece or bullet of known weight, various sizes of which, as well as cases, are kept in stock by the assayer. The lead so placed in the furnace rapidly melts and becomes covered with a grey oxide, but soon after appears fluid and brilliant; and at this point the assays are charged by means of a pair of tongs, great attention being given that no part overhang or touch the edge of the cupel. The assays are thus drawn into the mass of molten lead, and any particles of silver are in this manner prevented from adhering to the sides of the cupels in charging; sufficient despatch being used to obviate the fusion of the assay in its transition. The assays being charged in order on their respective cupels, and the furnace

previously filled with fuel, cylinders of charcoal, about six inches long, are inserted in the mouth of the muffle, so as to fill up the orifice in the furnace. The object of this is, that the stream of air admitted to pass over the surface of the cupels, and which is necessary for the rapid oxidation of the lead, may not chill the muffle and retard the progress of the assay. By displacing one or more of these pieces of charcoal, the assayer can increase the current of air, while at the same time he is enabled to inspect the operation as it proceeds.

In the first instance, dense fumes will be observed to rise from the melted metal, indicating the oxidation and subsequent volatilization of the lead. These continuing some time are then followed by the appearance of small luminous points on the surface, which increase in size and brilliancy as the operation progresses. And then a minute stream of red fused matter is seen to flow from the top of the silver globule, and circulate around it, which is carried down and absorbed by the cupel. This arises from the vitrifaction of the lead by the air, which at the same time oxidates the copper.

As the cupellation advances, the fumes gradually lessen in density till they disappear altogether. The melted button at this stage is observed to become more convex and round; and as the last vestiges of the lead and alloy are being carried off, it assumes a cloudy appearance on the surface, changing to large bright points of the fused oxide, till at length it is nearly freed from all impurity. At this point the noble metal displays some singular and beautiful characteristics. Deprived of all the base alloys save the last minute portion that tarnished its lustre, it has become bright and pure, and gives forth from its surface irridescent circulating rays of light, which indicates the successful completion of the process.

During the operation, the assayer's attention should be directed to the heat of the furnace, which must be neither too hot nor too cold: if too hot, minute portions of silver will be carried off with the lead, and so vitiate the assay; moreover, the pores of the cupel being more open, greater absorption will ensue, and there is liability to loss from that cause. One indication of an excess of heat in the furnace, is the rapid and perpendicular rising of the fumes to the ceiling of the muffle, the mode of checking and controlling which has been pointed out in the description of the improved furnace.

When the fumes are observed to fall to the bottom of the muffle, the furnace is then too cold; and, if left unaltered, it will be found that the cupellation has been imperfectly performed, and the silver will not have entirely freed itself from the base metals.

The white, or dark appearance of the cupels, may also afford some guide to the operator; but in such cases practice and experience are the best instructors; and it is not possible, in a general description, to measure out the precise degree of heat necessary to the perfection of the process.

The cupellation completed, great care is required with regard to the cooling of the globules, for if that process be not allowed to take place gradually, they will "spring" or burst, and throw out particles of pure metal from the interior. This arises, as is generally supposed, from the exterior portion cooling too rapidly, which forms a sort of shell that, shrinking as it cools, presses on the still liquid fluid and makes it spurt out; but others have suggested that the cause of "springing" as it is called, is to be attributed to the disengagement of a small portion of oxygen combined with the melted silver.

The globules being cool are removed from the cupels with a pair of pincers, and struck on the edge with a hammer on the anvil, in order to remove any oxide or extraneous matter adhering to the under surface, and are further cleaned with a "scratch-brush," made of fine wire bound firmly together. After this, having been carefully placed in their compartments, they are weighed with the greatest nicety, the loss in weight indicating the amount of alloy abstracted; and affording the *apparent* quantity of pure metal in the pound. But into the assayer's calculation certain considerations enter, derived from long experience and observation during the process, which make the actual result of the assay button only an approximation to the actual quality of the metal under examination. For, supposing the operation to have been perfectly performed, he finds it necessary, for example, to make some compensation for a certain amount of silver, not lost, but absorbed in the cupel itself, which he knows to have been abstracted from the assay.

Assaying.

This fact may be ascertained by reviving the oxide of lead from the cupel, and cupelling the lead by itself, when it will be found that the small globule of silver left on the cupel considerably exceeds the proportion of this metal in the lead, and will correspond nearly with the loss of silver in the assay. And it is manifest, therefore, if this were not taken into calculation in the assayer's report, the metal would appear less pure than it really is, all deficiency of weight being reckoned as alloy. It has been calculated, that when no more lead is used than is necessary to separate the alloy, there is carried down into the cupel as much silver as, when the whole is again reduced, would make the noble metal $\frac{1}{128}$th of the mass, when the natural admixture of the silver is only $\frac{1}{1152}$d. But if an excess of lead be employed, this loss of silver is somewhat greater, though it does not increase in the ratio of the excess of the lead.

French chemists, who impugn the accuracy and scientific nature of the process of cupellation as applied to the assay of silver, have generally adopted another very ingenious and delicate mode, called "*La voie humide*," or humid method, in contradistinction to the dry. This system is maintained to be more certain and accurate in its results by the French, but as English assayers are divided upon the point, it is not generally practised, and therefore we need not enter elaborately into a description of it.

This ingenious process was originally discovered by M. Gay-Lussac, the distinguished French chemist, by whose influence it was introduced into the Paris Mint and other establishments. In his "*Instruction sur l'Essai des matières d'Argent*," it is thus described:—"Le nouveau procédé d'essai que nous allons décrire consiste à déterminer le litre des matières d'argent par la quantité d'une dissolution de sel marin titrée, nécessaire pour précipiter exactement l'argent contenu dans un poids donné d'alliage."

The metal being dissolved in nitric acid, a quantity of salt is poured into it from a graduated vessel till the whole silver is precipitated in the state of chloride, a compound insoluble in water or even in acid. The quantity of chloride of silver precipitated is determined, not by weight, which would render the process tedious, but by the weight or the volume of the dissolved salt necessary to precipitate precisely the silver in the acid. The complete precipitation of the silver is easily recognized by the cessation of the cloudiness in the liquid, when the solution of salt is gradually converted into nitrate of silver In this process the presence of copper, lead, or any other metal in the solution of silver, does not in a sensible degree affect the quantity of salt necessary to the precipitation; that is to say, the same quantity of silver, whether pure or alloyed, requires a fixed and constant quantity of salt to effect its separation from the acid.

Though the theory of the process appear thus so extremely simple, in the practice of it, nice manipulation, and long experience as to the presence of other metals equally affected by the salt, are absolutely necessary; and these have carried it to such perfection that the results can be obtained with as much rapidity, and, *according to its advocates*, with more certainty and confidence than by the ancient mode of cupellation.

Silver parting assay.

It remains for us now to notice briefly the *silver parting assay*, or that by which the amount of gold contained in silver is discovered and determined: an assay which has become very common in modern times, in consequence of the discovery of the art of refining by sulphuric acid, whereby gold can be separated from silver at a comparatively small cost.

The button or globule resulting from the cupellation of the silver is simply digested with nitric acid in a glass bottle, or matrass, on a sand-heat, and the acid taking up the whole silver, leaves the gold at the bottom in the shape of a fine brown powder. The acid being poured off, the residuum is washed in warm water, and then allowed to fall into a small clay-vessel, or crucible, in which it is brought to a red heat, in order to expel any moisture. The weight is then ascertained, and the gold being deducted from the silver, shows the proportion of each metal in a given weight. The report of this assay is stated as follows:—B. 15 dwts. for silver; gold 12 grains per pound Troy. When the amount of gold exceeds one-quarter of the assay-specimen, or $\frac{25}{100}$ths, it is found necessary in practice to treat it as a gold assay.

Gold assaying.

We proceed now to describe the process of assaying gold, which, as greater values are affected, demands even more care and attention than that of silver.

The preliminary process exactly resembles the one already described, the object of cupellation in this case, as in the other, being to destroy the base metal or alloy contained in the gold. If gold contained only copper as alloy, the assaying of gold would be as simple as that of silver, the globule of fine metal on the test indicating by weight the quality of the specimen operated on, as in the case of silver. But as gold generally is found to contain a portion of silver in combination, and as silver is not destroyed by cupellation, it will be manifest that another process is required to separate the silver from the gold. To effect this object recourse is had to the "*parting process*." This is done by means of nitric acid, which entirely dissolves the silver, and leaves the gold perfectly pure. But as gold does not commonly contain sufficient silver to allow of the action of the acid and complete dissolution of the silver, it is found necessary in all gold assays to add from 2 to 3 parts of fine silver on the cupel. In this manner the particles of gold are disseminated, and no longer protecting the silver from the acid, the dissolution is easily accomplished.

In the first stages of the operation the same remarks are applicable as were previously made on the assay of silver. The specimen to be examined is rolled or hammered out, and a piece taken from it free from extraneous matter; it is then nicely weighed against the integer, or *assay pound*, the assayer exercising his judgment on the metal as to its various characteristics of colour, &c., so as to determine the addition of pure silver necessary, with other alloys, to effect the solution in boiling acid, the proportion required being full $\frac{2}{3}$ds of the whole.

The silver added is then placed with the gold assay in a case of lead weighing half that necessary to complete the process; and if there be a number, they are arranged on the board as formerly described, ready to be charged *seriatim* into the cupels prepared in the furnace. The remainder of the lead is then added, and the process of cupellation proceeds as before.

The assays having passed the cupel successfully, they are flattened on a polished anvil, three well-directed blows with a heavy hammer being sufficient to reduce them to the proper form and thickness to pass through the flatting-mill. This is worked by hand, and reduces the pieces to thin plates or laminæ about $\frac{1}{30}$th of an inch thick, which are annealed or softened, and, to avoid confusion, they are placed on the "annealing iron" (fig. 36), from which they are taken one by one and carefully rolled up with round-nosed pliers, in such a manner that the acid may penetrate between each fold. They now resemble coils of silver, and are ready for the parting process.

From time immemorial *sand-baths* have been used for boiling the acid, deemed the safest and best for matrasses or bottles of glass, liable at all times to break by undue expansion caused by the sudden and irregular application of heat. But as gas in modern times has been applied to many useful purposes, so amongst others it has been successfully employed in boiling the parting assays.

The *sand-bath* is a somewhat clumsy contrivance, consisting of a square copper pan covered with fine sand about an inch in depth. This is placed over an open charcoal fire, and three-quarters of an hour are required to properly heat the sand. Flat-bottomed, conical glasses, containing the assays and acid are placed on the bath, and the liquid allowed to boil; and by changing the glasses from time to time, so as to equalize the ebullition of each, very satisfactory results have generally been attained. But this plan has been recently improved upon by Mr H. W. Field of the Royal Mint, by the introduction of his apparatus by which gas is used to boil the acid, and which is effected more expeditiously, with as much safety, and with more economy. This apparatus will be seen by reference to fig. 41 to 49. Plate LXXV.

The flasks or bottles which are round-bottomed, lighter, and more tapering than the old matrasses, are placed on the gas-jets, and in five or ten minutes the acid is hot enough to receive the assays. By means of this 45 assays can be operated upon at the same time. The assays being charged, the acid is seen instantly to attack the alloy with great vehemence, which becomes oxidized by abstracting a portion of oxygen from the nitric acid, giving forth at the same time dense nitrous fumes. So long as these dark red fumes are visible the decomposition continues, but gradually they become fainter and fainter, till they disappear altogether. Lest some silver remain in the gold, protected from the action of the acid, the liquid is decanted, and its place supplied by some stronger acid, of the specific gravity of 1·35. This removes effectually any particles of alloy that may be incorporated with the gold.

In this process, the assayer's attention should be chiefly directed to the strength of the acid; for if it be too strong the cornet of gold is liable to be broken and reduced to powder, rendering the subsequent collection of the grains a work of difficulty; if too weak, a portion of silver or alloy will remain incorporated with the gold, and vitiate the accuracy of the assay. The specific gravity of the acid applied in the first instance should be about 1·2, three or four times the weight of the assay being added; in the second boiling, it should be about 1·35; but experience will be found a safer guide in such particulars than any definite rules. The principal object is to employ acid of the exact strength that will, after the silver has been extracted, maintain the cornet unbroken and of a spiral form. Regard must also be had to the proper proportion of silver added to the assay; for if that be in excess, the nitric acid is liable to reduce the gold to powder.

When the acid is in the act of violent ebullition, the assay will be found to rise in the glass and strike against it, and in order to prevent this the French assayers generally put into the liquid a piece of charcoal about the size of a pea, which forms a kind of nucleus, around which the acid boils; but this application, however simple, discolours the acid and renders it useless. At the Royal Mint, in lieu of charcoal, the assayer uses small porous clay balls about $\frac{1}{8}$th of an inch in diameter, which have not that objection, and being washed in boiling water after use they can be employed again and again.

Before the cornets are removed from the glasses, the hot acid is carefully decanted, and the flasks filled with warm distilled water, so as to wash away the remaining acid, and any residue of silver. This should be repeated until the

liquid is seen to pour off perfectly clear. After this, the flasks being filled with water, they are one by one inverted over a small clay annealing pot, and the cornet of gold is allowed to fall gently through the water into the pot. These vessels are arranged in such a manner as to obviate any confusion, and secure the identification of the assay. The superfluous water being poured out of the pots, they are then placed in the furnace and annealed under a bright heat.

The cornets, by the action of the acid and by the separation of the silver, are thoroughly corroded, though their original form remains unaltered. They are in this state extremely brittle and porous, and when examined microscopically appear to resemble a very fine sponge. They bear a nearer likeness to pieces of brown earthenware than to gold. But after annealing, they regain all the properties of that truly noble metal; and being allowed to cool, they are carefully weighed against the assay pound, and the diminution of weight recorded. If they are weighed hot, it has been ascertained that a variation will occur of nearly ⅛th of a carat grain, and, therefore, such an error should be guarded against.

It is a matter of the greatest importance that the silver used in this process should contain no gold, otherwise a source of very material error would arise in the delicate operations of the assayer. The silver cannot be too pure, and a careful examination should be made of it before employing it for that purpose. The most certain mode of attaining that object is to precipitate silver from the nitrate, which cannot possibly contain any gold.

As in the case of the silver assay, certain compensations are found by experience necessary before an accurate report can be made of the gold assay. In the cornet it must not be supposed that we have before us an assay perfectly pure, as a previous paragraph may have suggested, or that no loss of precious metal has taken place during the process. Notwithstanding all the care and attention used by the assayer, it has been discovered that the cornet is not altogether free from silver; and it is manifest if this were not allowed for, the report would declare the gold to be finer than it really is. The amount of silver so remaining is estimated by the Mint Assayer to range between 4 and 9 grains Troy. But in this particular it is probable no two assayers will agree, as the allowance to be made depends on the practice of each. And what is gained to the assay by silver, is to some extent lost again, in the cupel and by the action of the acid. For, by the experience of Mr Field, an assayer of long practice, nitric acid does take up a small portion of gold, contrary to the general notion of chemists; which has been proved by laying aside the second or strong acid (employed more than once) in a conical-shaped bottle where it was permitted to remain. After some time a coating of gold was apparent at the bottom of the glass, and under the influence of light the whole interior of the bottle was coated up to the stopper when the acid reached so high.

Two bottles of acid that had been repeatedly used to digest gold assays for some years, yielded in this manner full 30 grains of gold. This fact has recently been confirmed by experiments made by Mr C. Sterry of the Mint, and also by that careful chemist and assayer Mr G. H. Makins of London.

Independently of these allowances and compensations, another must be made for variations caused by the particular process itself, as indicated by the trial piece put into the furnace along with the assays, and which in all respects passes the same ordeal. This standard piece of metal consists of a certain weight of gold of a known quality, and whatever variations it undergoes, the assays themselves are supposed to be subject to the same.

Gold is found to contain other metals beside silver and copper, such as platinum and the allied metals; and when that happens the assayer has to exercise his judgment in ascertaining the character of the metal and its amount. In ordinary cases, when the assay after cupellation contains gold and silver only, it assumes the appearance of silver; but if platinum be combined with it in any notable proportion, it will easily be detected by the crystalline surface of a dead white colour, covered with bright rough points; if palladium, the button assumes the appearance of an ordinary assay, but in the final clearing of the assay in the furnace it resembles an assay cooled too quickly; and while it tinges the acid a deep rich red colour, the former is marked by a pale yellow. Again, if iridium be in combination, it will mix mechanically with the gold in metallic grains; but, after passing through the fire, it will leave streaks of black powder on various parts of the cornet.

Assaying.

Small portions of platinum and palladium are removable by the acid; but, as iridium is insoluble in any acid, no means have yet been devised of separating it from the gold in the process of assaying.

Gold parting assay.

The "gold parting assay" is simply the process by which the silver is separated from the gold, so as to enable the assayer to report the contents, that the bullion-holder may realize the value. This is effected by dissolving the silver in the nitric acid, as before described in the common assay, and then ascertaining the amount of silver resulting in excess of the quantity used in the process, which indicates the amount of silver contained in the assay pound, and by computation in the Troy pound.

The gold coming from Australia, and particularly from California, is found to contain a considerable amount of silver, which can be separated easily and economically by the sulphuric acid process of refining, and recently this branch of assaying has also augmented far beyond what was required in former times.

The silver in solution resulting from the parting assay may be precipitated in the metallic state, by diluting the liquid with water, and then putting into it plates of copper. The silver being thrown down and washed carefully until the water be nearly tasteless, may then be dried and melted. This method, however, is considered offensive, because, in the action, there is a copious discharge of dark red noxious fumes of nitrous gas.

The plan now pursued by the Mint Assayer is to throw down the silver in solution as a chloride, by the addition of either common salt or hydrochloric acid, until all cloudiness disappear. The residuum is then collected in proper earthen pans, well washed, and slightly acidulated with hydrochloric acid, immediately immersing in the liquid plates of iron, which reduces the chloride to a metallic state. The plates are then taken out, and the silver first washed with hot water, containing a little hydrochloric acid, and then repeatedly with hot-distilled water till it pours off tasteless. The powder is then dried and melted.

In conclusion, we append a table of the gold assay weights, and their corresponding decimals; premising that in a few years the decimal system will probably supersede the ancient complex mode of notation.

Carats.	Carat Grains.	Eighths.	Troy Weight. lb.	oz.	dwt.	grs.	Decimals.
24	...	...	1	...	...	...	1·000000
12	...	...	...	6	...	...	·500000
6	24	...	...	3	...	...	·250000
3	12	...	...	1	10	...	·125000
2	8	64	...	1	...	...	·083333
1	4	32	...	...	10	...	·041666
...	2	16	...	...	5	...	·020833
...	1	8	...	...	2	12	·010416
...	...	4	...	...	1	6	·005208
...	...	2	...	...	...	15	·002604
...	...	1	..	...	...	7½	·001302

Assaying. Assay-balance.

A description of the process of assaying might be deemed incomplete without some reference to the assay-balance, which may be said truly to constitute the right hand of the assayer, and on the delicacy and accuracy of which depend, in a great measure, the truth of the results. With that view, we may be allowed to give a detailed description of a beautiful and ingenious balance recently adopted in the Royal Mint, constructed on improved principles by Mr G. H. Makins, practical Chemist and Assayer, Coleman Street, London, and manufactured by an excellent workman, Mr Oertling of Store Street. It seems to combine all the advantages of modern improvements, both in design and workmanship, and in practice must amply fulfil the most sanguine expectations of the inventor.

In a good assay-balance three essentials are indispensable,—1. It should be quick in its action; 2. It should be constant and uniform—that is, oscillate to the same point of the index with the same weight to any number of weighings; 3. It should be extremely sensible and delicate, indicating the minutest shades of difference. As, however, the sensibility of a balance is found to diminish as the quickness of action is increased, the centre of gravity being lowered, one of the excellencies of the balance alluded to consists in the nice adjustment of these two opposing qualities.

The beam is what is generally called a skeleton-beam, 10 inches long, $\frac{1}{2}$ an inch deep at the fulcrum, tapering off at each end to the $\frac{1}{3}$d of an inch. At the centre it is about $\frac{1}{10}$th of an inch in thickness, decreasing at the ends to the $\frac{1}{20}$th of an inch. The weight of the beam is only 85 grains; and therefore it contains little more metal than is necessary to secure the several parts together at the points of suspension.

The end adjustments, indicated by *a*, in fig. 52, Plate LXXV, for the length of arm, are similar to many other delicate balances, namely, a saw-cut with screws, to open and shut by pressure. The pendants, *b*, at each end, are supported by two hard steel-points, *c*, having a fine screw cut on each, with nuts to fix them, so as to obtain a perfectly straight line, touching all the points of suspension. These pendants or pans, *d*, with the skiffs, *e*, are hung on these points by means of steel-plates, having a cup-shaped cavity for the one, and a groove for the other. It would be impossible for the most skilful workman to form two cups so accurately as to *plumb* or adjust themselves with mathematical precision to the points of suspension.

As the weight used with this balance rarely, if ever, exceeds 20 grains, the parts of contact where friction occur have been reduced to mere points, and in consequence the wear is very slight.

One peculiarity of this balance is the use of a weight called a *rider*, represented by *f*, supposed to be a German invention, which is placed or rests on the beam itself, and depresses it; the beam being divided in its length into ten parts, and the rider placed on any part, the weight is ascertained, and thus allows of an easy and simple mode of weighing decimally. The rider, *f*, is carried from one point or division of the beam to another, or may be altogether removed by a movable arm, *g g*, worked by the hand from the outside, *h*, of the case or lantern. It travels or traverses the beam on a stage, *i*, fixed from side to side of the lantern at *k k*; and in this manner the small or fractional weights may be ascertained without subjecting the beam to disturbance by the admission of air upon opening the glass-door, *l l*, of the case B.

A, represents the outline drawing of the balance and apparatus; the supports being of massive construction in order to obviate any tremulousness. They consist of two pillars, *m m*, fixed on a base, *n*, and on the top of these columns a table is fixed, *o*, with two upright pieces, *p p*, rising from it, to which are attached the agate bearings, formed of an elliptical shape, and presenting therefore the smallest points of contact to the knife edges. A corresponding table, *q*, is fixed to the rods, *p p*, which move up and down the pillars, *m m*, and by means of the lever handle, *r*, give action to the beam. The table has two mortices in it exactly fitting the upright pieces, *s*, which carry the agate-bearers, and upon these uprights the table slides up and down. On the outside of this second table, *q*, is a crutch or Y, *t*, which raises the beam from its bearings when it is thrown out of action.

The beam, on being depressed, acts first upon the arms of two rollers, fixed under the lantern, whose opposite arms depress the ivory tables supporting the pans; and at the point when the tables are free, the lever has reached a connecting stirrup between the movement rods, and then begins to lower the beam upon the agate bearers. The tops of the ivory tables that support the pans are of a spherical shape, *v v*, fixed upon the tables *w w*, so as to admit of the least possible contact; and the pans have the curve of a radius exactly equal to the distance between the ivory table and the point of suspension; so that, if they are found to swing out of the perpendicular during the act of weighing, they will be caught by the tables when they rise upwards; *y y* are spirit-levels.

In this balance there are adjustments for the amount of fall of the fulcrum to the agates, as well as for the rise of the ivory-tables to the pans; but the former is small in amount. The pillars being placed at the distance of $1\frac{1}{2}$ inch apart, and the index-needle, *x*, long—extending 6 inches downwards—a good scale of division is obtained; while the motion of the index-needle being nearly level with the pans, a great advantage is secured in use. (R. M—T.)

Asselyn || Assemani.

ASSELYN, Hans, a distinguished Dutch painter, was born at Anvers in 1610, and became the disciple of Esaias Vandervelde, the battle-painter. He distinguished himself in historical painting, battles, landscapes, and animals, particularly horses. He travelled into France and Italy, and was so pleased with the manner of Bamboccio that he always followed it. He was one of the first Dutch painters who introduced a fresh and clear manner of painting landscapes in the style of Claude Lorraine; upon which all the painters imitated his style, and reformed the dark brown they had hitherto followed. Asselyn's pictures were in high esteem at Amsterdam. He died in that city in 1660. Twenty-four pieces of landscapes and ruins, which he painted in Italy, have been engraved by Perelle.

ASSEMANI, the surname of three learned Maronite Syrians, who flourished in Italy in the last century. The eldest, and the most learned of the three, *Giuseppe Simone*, was born at Tripoli in Syria, in 1687. Having been sent to Rome to receive a classical education, he soon distinguished himself by his learning and industry, and was chosen by Pope Clement XI. to go and visit the convents of Egypt and Syria, in search of ancient MSS. with which to enrich the library of the Vatican. He executed his commission with great success, and in reward for his services was made archbishop of Tyre, and librarian of the Vatican. His principal work is his *Bibliotheca Orientalis Clementino-Vaticana*, in 4 folio volumes, 1719–28, which contains valuable biographical notices of Syrian Christian authors. He also published, in 6 vols. fol. (Lat., Greek, and Syriac), 1732–34, the works of St Ephraem, a Syrian father of the Church. He died at Rome in 1768 at the age of 80. *Stefano Evodio*, his nephew, was created bishop of Apamea, and succeeded his uncle as librarian. He also published two folio volumes of Oriental Catalogues of Vatican MSS. and other archæological works of merit. *Simone*, the grand-nephew of Giuseppe, born at Tripoli in 1752, was long professor of Oriental languages in the University of Padua, where he died in 1821. He is best known by his masterly de-

tection of the literary imposture of Vella, a pretended history of the Saracens in Sicily, which was confirmed by the German Hager.

ASSEMBLY. This word, besides its well-known social application to meetings for purposes of conviviality or gaiety, is a term by which important political and ecclesiastical bodies have become known in history and jurisprudence. The original use of the term is in the French *Assemblée.* It is applied in early history to those *Assemblées du Champ de Mars*, or *Assemblées de Mai*, of which the historical notices are so uncertain that they are not clearly distinguishable from the meetings of the States General or great vassals of the crown. On the occasion of the meeting of the States General in 1789, a memorable use was made of this dubiety of expression, and the term National Assembly was applied to the assemblage, when the third estate or commons revolutionized its character by resolving to sit and act whether they were joined by the other orders or not. Of the history of this body a full account will be found under the head of FRANCE.

The application of the term *Assemblée* in France to the meetings of the clergy, elsewhere generally called councils, is evidently the source of its transference to Scotland, through Knox's intercourse with Calvin. The General Assembly thus became the fixed designation of the supreme collective council, legislative and judicial, of the Scottish Church. The first Assembly, when the system was of course but imperfectly developed, was held in 1561. In the subsequent ecclesiastical contests, of which an account will be found under the head of SCOTLAND, it was the object of the Presbyterian party, in opposition to the Episcopalian party and the crown, to vest a supreme and independent authority over ecclesiastical affairs in the General Assembly. In the memorable Assembly held at Glasgow in 1638, this supremacy was for a time accomplished; and after having abolished the Episcopal hierarchy, the body continued to sit and act after it had been required by royal authority to dissolve. It was the principle of Cromwell's government to tolerate the various Protestant communities in their worship and ordinances, but not to permit any of them to assemble in deliberative bodies. Those who vindicate his policy hold, that when ecclesiastical disputes are merely local, the influence of the victorious majority in one place is neutralized by the superiority of its opponents in another; while, if they were permitted to meet and fight pitched battles, the stronger party would crush or drive out the weaker. During the Commonwealth, this view was in some measure confirmed by the existence in Scotland of two opposite clerical parties, which, though denouncing each other, never afforded an opportunity by meeting in assembly for a critical trial of strength. At the Restoration, the suppression of the Assembly was continued on different grounds. Along with the inferior church judicatories, it was restored at the Revolution. William III., however, and his advisers, by no means admitted the claims of entire independence of the state claimed for the church, and more than once a contest appeared inevitable. He was accustomed to convene and dismiss the Assembly at his pleasure. At all times the Scottish church has denied this power to the royal prerogative, but methods were found for avoiding a discussion of the point. It came to be the practice for the Assembly to meet and separate on certain established days; and by a device adopted soon after the Revolution, the royal commissioner, in the name of the sovereign, adjourns the Assembly on its last stated day of meeting to the stated day for recommencing; and the elected moderator, without appearing to notice this proceeding, makes identically the same adjournment, solemnly proclaiming it in the name of "the Lord Jesus Christ," as the Head of the Church. The Assembly consists of representatives, clerical and lay, from the several presbyteries of the church, and of a few other members. It is a general characteristic feature, that the clergy are always the majority. When the Free Church separated from the Establishment in 1843, it constituted a General Assembly on the same principles; and, being a voluntary church, has not of course been embarrassed by any questions with the crown. The several bodies of dissenters from the Church of Scotland, who became combined together as the United Presbyterian Church, give the name of Synod to the general aggregate body of their members, corresponding with the General Assembly in the other Scottish Presbyterian bodies.

The Westminster Assembly of divines was a memorable and important adoption for a short period in England of the Scottish system. It was the creature of that remarkable influence exercised by the Scottish party ere the Independents and the army had asserted their preponderance. It followed the victories of the Scottish arms, and those exhortations of the covenanting preachers in London which obtained so much attention and popularity in the eventful epoch of the conflict between the parliament and the crown. In the negotiations conducted at Oxford in 1643, one of the bills to which the royal sanction was demanded, was termed "A bill for calling an assembly of learned and godly divines and others to be consulted with by the parliament, for the settlement of the government and liturgy of the Church of England, and for vindicating and clearing of the doctrine of the said church from false aspersions and interpretations." The measure was at length passed as an ordinance by the authority of parliament. From the commencement, indications of the growing power of the Independents is perceptible in the cautious jealousy of the parliament, which required the assembly to inquire and report to the legislature, instead of conferring on it independent powers. The Assembly nominally sat for five years; but for some time before it was extinguished by Cromwell, it lost the confidence and co-operation of parliament. It consisted of 121 clergymen and certain lay assessors. From that peculiar union with Scotland manifested in the adoption of the Scottish Covenant as the Solemn League and Covenant of the two nations, some Scottish members were admitted as representatives of the General Assembly, and exercised a predominant influence on the deliberations. Of the documents adopted by them, one, the Directory of Worship, received the nominal assent of the English parliament. The Confession of Faith was received with some modifications. Both these documents, however, along with the Larger and Shorter Catechisms, were received into the Church of Scotland, and have since remained unaltered, as "agreed upon by the Assembly of Divines at Westminster, with the assistance of commissioners from the Church of Scotland, as a part of the covenanted uniformity in religion betwixt the churches of Christ in the kingdoms of Scotland, England, and Ireland." (J. H. B.)

ASSEN, a town of the Netherlands, capital of the province of Drenthe, containing 2800 inhabitants. It is 16 miles south of Groningen, and is connected with the Zuyder-Zee by the Smilder canal. It has a considerable trade in corn.

ASSENEDE, a town of Belgium, province of East Flanders, 12 miles N.N.E. of Ghent. It has some woollen and cotton manufactures, soap-works, &c. Pop. in 1851, 4131.

ASSENHEIM, a jurisdiction belonging to the Counts of Solms Rödelheim and Assenheim, now mediatized to the Grand Duchy of Hesse-Darmstadt. It is in the province of Upper Hesse. Its chief town, of the same name, is situated at the confluence of the Wetter and the Nidda. Pop. 800.

ASSENS, a seaport town of Denmark, situated upon the Little Belt, a strait of the Baltic which separates the isle of Fuhnen from the continent. It is the ordinary port for the traffic between the duchy of Sleswick and Fuhnen. Pop. 2700. Long. 9. 55. E. Lat. 55. 15. N.

ASSER, John, or Asserius Menevensis (*Asser of St David's*), was born in Pembrokeshire in South Wales, and educated in the monastery of St David's by the Archbishop Asserius, who, according to Leland, was his kinsman. In this monastery he became a monk, and by his assiduous application soon acquired universal fame as a person of profound learning and great abilities. King Alfred, the munificent patron of genius, about the year 880 sent for him to court and made him his preceptor and companion. As a reward for his services, he appointed him abbot of two or three different monasteries; and at last promoted him to the episcopal see of Sherburn, where he died and was buried in the year 910. He was, says Pitts, a man of happy genius, wonderful modesty, extensive learning, and great integrity of life. He is said to have been principally instrumental in persuading the king to restore the university of Oxford to its pristine dignity and lustre. He wrote the life of Alfred (*De Vita et Rebus Gestis Alfredi*), first published by Archbishop Parker in the old Saxon character, at the end of Walsingham's *Hist.* Lond. 1574. It was reprinted at Frankfort in 1603, in folio, and in 8vo at Oxford in 1722. Various other works are ascribed to Asser by Pitts and Leland.

ASSESSOR, among the Romans, was a term generally applied to a trained lawyer who sat beside a governor of a province or other magistrate, to instruct him in the administration of the laws. The system is still exemplified in Scotland, where it is usual in the larger towns for municipal magistrates in the administration of their civil jurisdiction to have the aid of professional assessors. In municipal corporations in England, officers with the same name are appointed to assist at the election of councillors and ascertain the result.

ASSETS, a technical English law word, derived through the old Norman phraseology from the same source as the French *assez*, enough. Assets are real or personal. Where a man hath lands in fee-simple, and dies seised thereof, the lands which come to his heirs are assets real; and where he dies possessed of any personal estate, the goods which come to the executors are assets personal.

ASSIDEANS, or Chasidæans (from the Hebrew *chasidim*, merciful, pious), those Jews who resorted to Mattathias the father of the Maccabees, to fight for the law of God and the liberties of their country. After the return of the Jews from the Babylonish captivity, there were two sorts of men in their church,—those who contented themselves with that obedience only which was prescribed by the law of Moses, and who were called *Zadikim*, i.e., the *righteous*,—and those who, over and above the law, superadded the constitutions and traditions of the elders, and other rigorous observances: these latter were called *Chasidim*, i.e., the *pious*. From the former sprung the Samaritans, Sadducees, and Caraites; from the latter the Pharisees and the Essenes. See 1st Macc. ii. vii.; 2d Macc. xiv. The name of Chasidim has also been assumed by a Jewish sect which originated in Poland about a century ago, and still exists.

ASSIDUI, or Locupletes, *i.e.*, tribute-payers, Roman citizens of the upper and wealthier classes, so designated by Servius Tullius, in contradistinction to the *Proletarii*, or those who benefit the state only by their progeny (*proles*). Cicero says, "*locupletes assiduos appellasset ab ære dando.*" —*Repub.* ii. 22.

ASSIGNAT, the name given to a peculiar species of paper money issued during the first French revolution. The influence of the system, operating along with the other attempts to regulate trade, form a prominent feature in the calamitous history of the epoch. The share borne in it by the assignats is at the same time a memorable instance, for the use of the economist and financier, of the hopelessness of projects for creating or preserving national wealth by an issue of paper money, not the representative of available wealth and real business transactions. The first issue of assignats was made in the security of the forfeited ecclesiastical property, and was adopted as a preferable alternative to throwing the forfeited lands on the market, which it was no doubt judiciously believed that so large an amount of property would glut. The holder of the assignats might use them as money, or claim the land which they represented. As more forfeitures occurred, the issue of assignats was increased. But it soon ceased to be measured by property, and was enlarged according to the exigencies of the revolutionary government. The paper money fell to half, then to a sixth part of the value of the same denomination in silver, and sinking rapidly through successive grades of decrease, silver held at last the value of 150 times its denomination in paper. In August of 1773, 3776 millions of francs were thus put in circulation: and virtually the assignats became worthless. The establishment of the maximum, and the other tyrannical interferences with trade by which revolutionary governments endeavour to support credit, have their proper place, along with the account of the condition of the country during the depreciation of the assignats, under the head of France. (J. H. B.)

ASSIGNMENT, Assignation, Assignee, are terms which, as conjugates of the verb assign, are of frequent technical use in the law of the different parts of the United Kingdom. To assign is to make over, and the term is generally used to express a transference by writing, in contradistinction to a transference by actual delivery. In England the usual expression is assignment, in Scotland it is assignation. The person making over is called *assignerer*, *assigner*, or *cedent*; the recipient, *assignee*. This last term is of important application in the law of bankruptcy in England and Ireland, as expressing persons of two classes, the official assignees and the trade assignees, to whom the realization and distribution of the bankrupt estate is committed. See Bankruptcy. (J. H. B.)

ASSIMILATION, in *Physics*, is that action or process by which bodies convert other bodies into their own substance and nature.

ASSINIE, a country of Upper Guinea, in Africa, at the western extremity of the Gold Coast. On the river of the same name, the French in 1843 established a factory.

ASSISI, a city in the delegation of Perugia, in the papal territory of Italy. It contains about 5000 inhabitants, depending chiefly for subsistence on the devotees, who, to the number of many thousands, make annual pilgrimages to the cathedral. This cathedral contains the tomb of St Francis, the founder of the Franciscan order. The poet Metastasio was born here in 1698. Long. 12. 24. 50. E. Lat. 43. 4. 22. N.

ASSITHMENT, a wiregeld, or composition, by a pecuniary mulct; from the preposition *ad*, and the Sax. *sithe*, *vice; quod vice supplicii ad expiandum delictum solvitur.*

ASSIZE, in old English law-books, is defined to be an assembly of knights and other substantial men, together with a justice, in a certain place and at a certain time; but the word, in its present acceptation, implies a court, place, or time, when and where processes, whether civil or criminal, are decided by judge and jury. In Scotland the word assize is still technically used to denote the fifteen persons who, deciding on criminal charges, are colloquially termed the jury.

ASSOCIATION (from the Latin *associare*, to join in fellowship), the act of associating or constituting a society or partnership, in order to carry on some scheme or business with more advantage. See Societies. On the influence of association as a political engine, see Agitation. For associations of workmen and employers, see Commandite.

Association of Ideas. See Metaphysics.

ASSOILZIE, in *Law*, to absolve by sentence of court.

ASSONANCE, in *Rhetoric* and *Poetry*, a term used where the words of a phrase or a verse have the same sound

or termination, and yet make no proper rhyme. These are usually accounted vicious in English. *Assonant Rhymes* are common among the Spaniards; thus *ligera, cubierta, tierra, mesa,* answer each other in a kind of *assonant* rhyme, having each an *e* in the penult syllable, and an *a* in the last.

ASSUAY, the most southern department of Ecuador, in South America. Cuença, Loxa, Jaca, and Borga, are its principal towns. Its chief productions are cinchona bark and silver.

ASSUMPSIT, in the *Law of England*, a voluntary promise, whereby a person assumes or takes upon him to perform or pay anything to another.

ASSUMPTION, a festival of the Romish church, in honour of the miraculous ascent of the Virgin Mary into heaven. The Greek church also observes this festival, and celebrates it on the 15th of August with great ceremony.

ASSUMPTION, in *Logic*, is the minor or second proposition in a categorical syllogism.

ASSUMPTION, *Deed of*. See SCOTS LAW.

ASSUMPTION, or ASSONGONG, one of the Marianne or Ladrone Islands in the Pacific Ocean, of a conical figure, dreary aspect, and almost totally covered with lava from the eruptions of a volcano in the centre. It has no anchorage near the shore. Long. 145. 55. E. Lat. 19. 45. N.

ASSUMPTION, the capital of the province of Paraguay in South America. It is situated on an obtuse angle formed by the eastern bank of the river Paraguay, 18 miles above the junction of the first mouth of the Pilcomayo, and 48 above that of the second. It was originally a small fort, but, from the convenience of its situation, in a few years it became a city, and in 1547 was erected into a bishopric. The adjacent territory is rich and fertile in a high degree, and abounds in a great variety of fruits. The air is temperate and the climate salubrious; the trees are perpetually green, and the rich pastures in the neighbourhood feed numerous flocks of cattle. The city is inhabited by Spaniards, Indians, and Mestizoes, who trade in hides, tobacco, and sugar. The Paraguay affords a channel of communication with Buenos Ayres; but the passage is long, owing to the rapid flow of the waters of that river: this, however, is considerably obviated by the favourable winds which blow from the south for a great part of the year. Pop. 12,000. Long. 57. 37. W. Lat. 25. 16. S.

ASSUMPTIVE ARMS, in *Heraldry*, are such as a person has a right to assume with the approbation of his sovereign and of the heralds.

ASSURANCE, or INSURANCE. See INSURANCE.

ASSUS, afterwards *Apollonia* (Pliny, v. 32), an ancient city of Mysia, on the Gulf of Adramyttium, was the birthplace of Cleanthes the Stoic, and for some time the residence of Aristotle. Its ruins are contiguous to the modern village of Beiram, 35 miles W.S.W. of Mount Ida; and the whole is said by Colonel Leake to give, perhaps, the most perfect idea of a Greek city that anywhere exists.—Leake's *Asia Minor*, p. 128; Fellows's *Asia Minor*, p. 46.

ASSYE, in Southern India, a village in the native state of Hyderabad, or dominions of the Nizam, situate on the tongue of land inclosed between the rivers Juah and Kaitna. This place is rendered famous in Indian history, by a decisive victory gained on the 23d September 1803, over the combined armies of Scindia and the Rajah of Berar, by Colonel Wellesley, afterwards Duke of Wellington. The British troops engaged in this battle amounted only to 4500 men, while those of the enemy consisted of nearly 50,000. The great disparity of numbers between the combatants, the skill and promptitude displayed by the British commander, combined with the valour of his men, and the signal defeat of the Mahrattas, all conspired to give a lustre to this action, which is scarcely surpassed by that of any other exploit in the annals of Indian warfare. Distance from Hyderabad, north-west, 261 miles. Lat. 20. 18. Long. 75. 55. (E. T.)

ASSYN-KALESSI, a village of Asia Minor, in Caria, occupying a peninsula among the branches of Mount Grius, with a mean but extensive fortress on the summit of the rock. This village stands on the site of the ancient Iasus, a considerable city, and many antiquities are still to be seen in it. Some of the most spacious sepulchres are at present inhabited by Greek families as their ordinary dwellings. Long. 27. 38. E. Lat. 37. 17. N.

ASSYRIA, the name of a country and empire of Asia, the capital of which was Nineveh. The boundaries of the country have been variously given by Greek and Roman historians. In its strictest and most original sense, it was applied to a long narrow district lying on the east side of the Tigris, and which is commonly called Assyria Proper. In a more extended sense, it comprehended the whole country watered by the Euphrates and Tigris, between the mountains of Armenia on the north, those of Kurdistan on the east, and the Arabian desert on the west; thus including not only Assyria Proper, but also Mesopotamia and Babylonia. It was also applied to the empire, the boundaries and extent of which varied with the character of its monarchs. Boundaries.

Assyria Proper was bounded on the north by Armenia, on the west and south-west by the Tigris, which separated it from Mesopotamia and Babylonia, on the south-east by Susiana, and on the east by the Zagros chain, separating it from Media. It corresponded to the modern pashalic of Mosul, including the plains below the Kurdistan and Persian mountains.

The upper part of this region is rugged and mountainous; while to the south and south-west extend vast level plains, interspersed with low ridges of hills of sandstone, limestone, and gypsum. According to Mr Ainsworth,—"Assyria, including Taurus, is distinguished into three districts; by its *structure*, into a district of plutonic and metamorphic rocks, a district of sedimentary formations, and a district of alluvial deposits; by *configuration*, into a district of mountains, a district of stony and sandy plains, and a district of low watery plains; by *natural productions*, into a country of forests and fruit trees, of olives, wine, corn, and pasturage, or of barren rocks; a country of mulberry, cotton, maize, tobacco, or of barren clay, sand, pebbly or rocky plains; and into a country of date trees, rice, and pasturage, or a land of saline plants." In the mountainous parts, iron, silver, copper, lead, and antimony, are found, and in the hills to the south-west are deposits of bitumen, naphtha, sulphur, and salt. Among the forest trees, pines, oaks, and ashes are common, as are also the walnut, mulberry, and plane; the last of which attains a great size. Besides the productions above enumerated, it yields gall-nuts, gum-arabic, mastich, manna, madder, castor-oil, and various kinds of grain, pulse, and fruit. In the mountain district, are bears (black and brown), panthers, lynxes, wolves, foxes, marmots, dormice, fallow and red deer, roebucks, antelopes, goats, &c.; and in the plains are found lions, tigers, hyænas, beavers, jerboas, wild boars, camels, &c. Bees are plentiful, producing honey of the finest quality. Natural Features. Products.

The two principal rivers which water this country, besides the Tigris, are its tributaries, the Great and Little Zab, both rising in the lofty mountains of Northern Kurdistan. The Great Zab rises in the elevated plateau between Lakes Van and Urumiyah, 7000 feet above the sea, and falls into the Tigris, after a winding course of 200 miles. The lesser Zab has several sources, the principal of which are about 20 miles south of Lake Urumiyah, and has a course of about 100 miles. The rivers Great and Little Zab divide this territory into three parts; that north of the Great Zab, called Aturia, was the most ancient seat of the monarchy, and contained Nineveh the capital; the part between the two Zabs was called Adiabene, and the part south-east of Rivers.

Assyria. the Little Zab contained the provinces of Apolloniatis and Sittacene. According to Ptolemy, Assyria was divided into six provinces, the most northern of which was Arrapachitis; south of it Calakine; then Adiabene, with Arbelitis to the north-east; while to the south lay Apolloniatis and Sittacene, mentioned above.

History. The labours of Messrs Layard, Rawlinson, Botta, and others, promise to throw much light upon the history and manners of the ancient inhabitants of this country. We shall, however, defer notice of their researches till we come to the article NINEVEH, in the expectation that, by that time, much additional light will be thrown upon this interesting subject, and shall, in the meantime, only give a short historical notice of the empire, founded principally on the sacred narrative; as, indeed, the accounts given by profane writers are so contradictory, and so mixed up with fables, that very little reliance can be placed upon them.

Being in the vicinity of Ararat, this district was early peopled after the Flood. From the word Asshur being used in Hebrew both as the name of Shem's second son, and for the country of Assyria, ambiguity has arisen as to the founder of this empire. In Genesis x. 11, the sacred historian, in speaking of Nimrod and his kingdom, adds—"Out of that land went forth Asshur, and builded Nineveh," or it may be translated as in the margin, "Out of that land he (*i.e.* Nimrod) went out into Assyria, and builded Nineveh." For reasons which it would be foreign to our present purpose to narrate, the latter reading is generally considered to be the more correct, and Nimrod is regarded as the founder of the Assyrian empire. For several centuries after this, Scripture is silent respecting the history of this country. In the days of Abraham, Chedorlaomer, a king of Elam, is mentioned (Gen. xiv.) as having, along with three other kings, invaded the territory of five petty princes of Palestine. These four kings, according to Josephus, were only commanders in the army of the Assyrian king, who had their dominion over Asia. In the time of the Judges, the Israelites became subject to a king of Mesopotamia, Chusan-rishathaim, who is by Josephus styled King of the Assyrians.

According to the Greek historians, the founder of the Assyrian empire was Ninus, who is represented as having conquered Babylon, Media, Egypt, and other countries. He was succeeded by his widow Semiramis, who must not, however, be confounded with another queen of that name who reigned some centuries later. She was succeeded, after a long and glorious reign, by her son, Ninyas, who, however, preferred luxurious ease and indulgence to martial glory. His example was followed by a long line of successors. In the reign of Teutames, one of these, the Trojan war broke out. Troy was then, according to Ctesias and other Greek writers, subject to the king of Assyria. This, however, seems very doubtful, as neither Homer nor Herodotus make any allusion to it. Of this degenerate race, Sardanapalus, the last of the dynasty, was the most effeminate and voluptuous. His feeble administration prompted Arbaces, the governor of Media, to revolt, a measure in which he was encouraged by the advice and assistance of Belesys, a Chaldean priest, who persuaded the Babylonians also to assert their independence. These provinces, aided by the Persians and other allies, attacked the Assyrians, defeated their army, and took the capital after a siege of two years. The king, to prevent his falling into the hands of his enemies, collected all his treasures, his wives, and concubines, within the palace, which he then set on fire, and thus perished.

After the death of Sardanapalus, the Assyrian empire was divided into three kingdoms, namely, the Median, Assyrian, and Babylonian. Arbaces retained the supreme power in Media, and nominated governors in Assyria and Babylon, who were honoured with the title of *kings*, while they remained subject and tributary to the Median monarchs.

The first king of Assyria alluded to in Scripture is he who reigned at Nineveh when the prophet Jonah was sent thither. Hales supposes him to have been the father of Pul, the first Assyrian monarch whose name is mentioned in Scripture, and dates the commencement of his reign B.C. 821. By that time the metropolis of the empire had become a magnificent and populous city; but one pre-eminent in wickedness. Pul invaded the land of Israel during the reign of Menahem, and obliged that king to purchase peace at the price of 1000 talents of silver (2 Kings xv. 19, 20). According to Newton, this event took place in the year 770 B.C. Hales agrees with Newton in supposing that at Pul's death his dominions were divided between his two sons, Tiglath-pileser and Nabonassar,—the latter ruling at Bablyon, and giving name to the "era of Nabonassar," which took its rise in his reign, B.C. 747. In the sixth year of the reign of Tiglath-pileser, Rezin king of Syria, and Pekah king of Israel, came up against Ahaz, and besieged him in Jerusalem. Ahaz thereupon sent messengers, with a large present to Tiglath-pileser king of Assyria, requesting his assistance. The Assyrian king accordingly invaded the territories of the confederate kings, annexed a portion of them to his own dominions, and carried captive a number of their subjects. In the year B.C. 729, he was succeeded by Shalman, Shalmaneser, or Enemessar. He made Hoshea, king of Israel, his tributary vassal, but finding him secretly negotiating with So or Sobaco, king of Egypt, he laid siege to the Israelitish capital, Samaria, and took it after an investment of three years (B.C. 719). He then reduced the country of the ten tribes to a province of his empire, carried into captivity the king and people, and settled Cuthæans from Babylonia in their room. Hezekiah, king of Judah, seems to have been for some time his vassal. We learn from Josephus, on the authority of the Tyrian annals, that he subdued the whole of Phœnicia with the exception of Tyre, which successfully resisted a siege of five years, and was at length relieved by his death in B.C. 715. Sargon, mentioned in Isaiah (xx. 1) as being king of Assyria, in whose reign Tartan, elsewhere mentioned as a general of Sennacherib, besieged and took Ashdod in Philistia, is by some supposed to be Shalmaneser or Esarhaddon, Sennacherib's successor; but Gesenius is probably more correct in thinking that he was a king of Assyria who succeeded Shalmaneser, and reigned only for two or three years.

The result of Tartan's expedition against Egypt and Ethiopia was predicted by Isaiah, while that general was yet on the Egyptian frontier at Ashdod. In the reign of Sennacherib, Hezekiah king of Judah threw off the Assyrian yoke, and allied himself with Egypt. This brought against him Sennacherib with a mighty host, who attacked and subdued the fenced cities of Judah, and compelled him to purchase peace with 300 talents of silver and 30 talents of gold. But notwithstanding this agreement, the king of Assyria was not long in returning to invest Jerusalem. By the divine interposition, however, a pestilence destroyed in one night the Assyrian army. Sennacherib himself fled to Nineveh, where he was slain by his sons, Adrammelech and Sharezer, about B.C. 709. The parricides fled to Armenia, and a third son, Esarhaddon, the Sacherdon or Sarchedon of Tobit, and the Asaradinus of Ptolemy's canon, ascended the throne. The earlier part of his reign seems to have been employed in subduing the provinces that had revolted against him. He settled colonists in Samaria; and it seems to have been in his reign that the captains of the Assyrian host invaded Judah, and carried Manasseh the king captive to Babylon, which appears to have been at that time the capital of the Assyrian empire. The subsequent history of the empire is involved in much obscurity. The Medes had already shaken off the yoke, and the Chaldeans soon appear on the scene as the dominant nation of Western Asia; yet Assyria, though

much reduced in extent, existed as an independent state for a considerable period after Esarhaddon. Hales, following Syncellus, gives as his successor a prince called Ninus (B.C. 667), who was succeeded (B.C. 658), by Nebuchodonosor, for the transactions of whose reign Hales relies on the apocryphal book of Judith, the authority of which, however, is very questionable. The last monarch was Saruc, (called also Sardanapalus,) in whose reign Cyaxares king of Media, and Nabopolassar viceroy of Babylon, besieged and took Nineveh, (B.C. 606). What remained of the empire was divided between the two victorious powers, and Assyria Proper became a province of Media.

Modern Assyria. The greater part of the country which formed Assyria Proper is now under the nominal sway of the Turks, who compose a considerable proportion of the population of the towns and larger villages, filling nearly all public offices, and differing in nothing from other Osmanlis. The pasha of Mosul is nominated by the Porte, but is subject to the pasha of Baghdad; there is also a pasha at Solymaneah and Akra; a bey at Arbil, a mussellim at Kirkook, &c. But the aboriginal inhabitants of the country, and of the whole mountain-tract that here divides Turkey from Persia, are the *Kurds*, the Carduchii of the Greeks; from them a chain of these mountains was anciently called the Carduchian or Gordyæan, and from them the country is now designated Kurdistan. Klaproth, in his *Asia Polyglotta*, derives the name from the Persian root *kurd*, *i. e.* strong, brave. They are still, as of old, a barbarous and warlike race, occasionally yielding a formal allegiance, on the west, to the Turks, and, on the east, to the Persians, but never wholly subdued; indeed, some of the more powerful tribes, such as the Hakkary, have maintained an entire independence. Some of them are stationary in villages, while others roam far and wide, beyond the limits of their own country, as nomadic shepherds; but they are all more or less addicted to predatory habits, and are regarded with great dread by their more peaceful neighbours. They profess the faith of Islam, and are of the Soonee sect. See NINEVEH.

ASTABAT, a small town of Persian Armenia, near the river Aras, 20 miles south-east of Nakschivan. The neighbouring country is fertile, and produces good wine. There is a root peculiar to this country, called *ronas*, used for dyeing red, great quantities of which are exported to India. Long. 46. 30. E. Lat. 39. N.

ASTAFFORT, a town of France, capital of a canton in the department of Lot and Garonne, arrondissement of Agen. Pop. 1318.

ASTELL, MARY, an English authoress, born at Newcastle-upon-Tyne in 1668. She was instructed by her uncle, a clergyman, in Latin and French, logic, mathematics, and natural philosophy. Having spent 20 years of her life in Newcastle, she went to London, where she continued her studies; and, deeply affected with the general ignorance of her sex, she published in 1697 a work entitled *A Serious Proposal to the Ladies, wherein a Method is offered for the Improvement of their Minds.* Her most finished performance was, *The Christian Religion, as professed by a Daughter of the Church of England*, published in 1705. She died in 1731.

ASTELL'S ISLAND, one of the English Company's islands, at the north-west part of the Gulf of Carpentaria, of moderate height, and wooded. Iron ore is found here. Lat. 11. 55. S.

ASTEROIDS (from ἀστήρ and εἶδος), a name given by Herschel to the new planets discovered between the orbits of Mars and Jupiter.

ASTERISK, a mark in form of a star (*), placed over a word or sentence, to refer the reader to the margin, or elsewhere, for a quotation, explanation, or the like.

ASTERISM, any small cluster of stars.

A-STERN, a sea phrase, used to signify anything at some distance behind the ship; being the opposite of A-HEAD, which signifies the space before her.

ASTI, a province of the duchy of Piedmont, in the continental dominions of the king of Sardinia. It is bounded on the north-east and east by Alessandria, on the south-east by Aqui, on the south-west by Alba, and on the west and north-west by Turin. It extends over 268 geographical square miles. It is a gently undulating plain, watered by the Tanaro and the Po; fruitful in all the productions of Italy, especially in corn, wine, and silk. Pop. in 1848, 136,065. Asti, (the ancient *Asta*) the capital of the province, is a large and well-built town, on the left bank of the Tanaro. It is the see of a bishop; and has a cathedral, a college, many churches and monastical institutions, with 24,000 inhabitants, who carry on a considerable trade in corn, wine, and silk, which is not a little promoted by the situation of the town on the high road from Alessandria to Turin and Coni. In the middle ages Asti was a great commercial city. Alfieri the poet was born here.

ASTLE, THOMAS, a well-known antiquary, was born in Staffordshire in 1734. His reputation, from his papers in the *Archæologia*, procured him in 1770 the parliamentary appointment of superintendent of the printing of the ancient records of the kingdom, which occupied him till 1775; when he was made keeper of the records in the Tower. His principal work is the essay on *The Origin and Progress of Writing*, published in 1784. He died 1st Dec. 1803.

ASTOMOUS (α and στόμα, *i. e., without a mouth*), a term used in zoology and in botany.

ASTORGA, a city of Spain, in the province of Leon, on a plain near the River Tuerto, and having the appellation of a marquisate, which title it confers on a noble family. It is surrounded with ancient fortifications, and has near it a castle in ruins. It has a cathedral, being the see of a bishop under the church of Compostella; and was called "the city of priests," from the great numbers of that profession formerly resident within its walls. Pop. 4000. Long. 6. 9. 53. W. Lat. 42. 27. 9. N.

ASTORIA, a settlement in the territory of Oregon, about 12 miles from the mouth of the Columbia River, named after Mr Astor, its founder, who had designed it for an extensive fur depôt. In 1813 it was taken possession of, in the name of Great Britain, by Captain Black of the Raccoon, who changed its name to Fort George; but at the close of the war it was restored to the United States. It now consists of only a few log-houses. It possesses a good harbour, which is chiefly used by the shipping of the North West Company, to whom Mr Astor sold the property.

ASTRABAD, or ASTERABAD, a small province of Persia, bounded on the north by the Caspian Sea and the desert, on the south by the Elburz Mountains, west by Mazanderan, and east by the River Gourgan. The country, although mountainous, and interspersed with deep forests, in which it is scarcely possible to travel, possesses beautiful and fertile valleys, producing rice, wheat, and other grains in abundance, or spread out in a boundless expanse of verdure, the pasturage of numerous flocks and herds. Fraser, who travelled through Persia in 1822, extols in the most lavish terms the appearance of the country. The soil, with little culture, is exceedingly productive, owing to the abundance of water which irrigates and fertilizes it. But while the province in many parts presents a landscape of luxuriant beauty, it is a prey to the ravages of disease, and the frequent incursions of the surrounding tribes. The heavy torrents which fall in the rainy season stagnate in the forests, forming morasses which, in the heats of summer and autumn, exhale a pestilential vapour, from the decomposition of the vegetable matter they contain. From these seats of noxious effluvia the wandering tribes of shepherds fly beyond the Gourgan or the Attruck, and live on the verge of the burn-

ing sand, although they have to carry water for each day's consumption from the distant river. The better classes retire from the intense heats of summer into the mountains; but the settled inhabitants of the villages, who cannot so easily remove, and who generally remain, suffer severely from sickness. The inhabitants, notwithstanding the unhealthiness of their climate, are a stout and athletic race. The revenue derived from this province by the king of Persia does not exceed the value of L.7000 sterling. It is famous, however, for furnishing a supply of matchlocks for the king's body-guard. This is the ancient Hyrcania, and is the native country of the Kadgers, a Turkish tribe, of whom the king is the head, and on whom he considers he can rely in times of danger.

Astrabad, or Asterabad, a town of Persia, the capital of the above province, is situated near the mouth of the River Gourgan, which flows into the Caspian, and at the head of a sheltered bay, extremely convenient for shipping. Astrabad is a pleasant, well-built town, about 3½ miles in circuit, and highly picturesque in appearance, from the buildings being intermingled with trees and extensive gardens. It was formerly larger, but Nadir Shah contracted it within its present limits. A mound of earth surrounds it, the remains of a mud wall once lofty and formidable, and defended by numerous towers, and also by a wide and deep ditch, now almost filled with rubbish. Astrabad owes its origin to Yezzen-ibn-Messlub, an Arab chief of great celebrity, who commanded the armies of Soliman, the seventh khalif of the Ommiades, about the beginning of the seventh century. It was destroyed by Tamerlane. In 1744 Hanway visited this place, and attempted to open a direct trade with it from Europe. It has now but little trade; and the bazaars, though extensive, are but poorly filled, containing little more than the necessary supplies for the consumption of the place. The number of houses within the walls is estimated at from 2000 to 3000. The town is extremely unhealthy during the hot weather, owing to the noxious exhalations of the surrounding forests. Distance N.E. of Ispahan 400 miles. Long. 54. 25. E. Lat. 36. 50. N.

ASTRAKAN, a government of European Russia, bounded on the south-east by the Caspian Sea, north-east by Orenburg, north by Saratov, west by the country of the Don Cossacks, and south-east by the Caucasus. It lies between Lat. 44. 50. and 49. 50. N. and between Long. 43. 30. and 51. 0. E. It has an area of about 50,000 square miles, divided into two nearly equal parts by the Volga, and consists chiefly of sandy deserts, interspersed with saline lakes; but in the delta and on the banks of the rivers, grapes and other fruits of southern climates are raised. The population in 1846 was estimated at 284,400, comprising Russians, Tartars, Georgians, Armenians, Persians, Hindus, &c., who engage in the rearing of horses, cattle, and sheep, and also in the fishing of sturgeon, which forms the principal source of wealth to the government. The annual revenue derived from this source is estimated at from two to three million of rubles. The vicissitudes of climate are great: with a mean annual temperature of 48° Fahr., the summer averages 70°, and the winter 13° Fahr.

Astrakan, the capital of the government of the same name, is situated on a small island in the Volga, about 30 miles above the influx of that river into the Caspian. It consists of three parts, 1. the *Kremlin* or citadel, which stands on a hill, and contains the cathedral, a spacious brick edifice with the archbishop's palace and the convent of the Trinity; 2. the *Belogorod* or white town, containing the government buildings, bazaars, &c.; 3. the *Llobodeo* or suburbs, where the bulk of the population reside. In the last the streets are narrow, irregular, and mostly unpaved, and the houses are built of wood. It is the seat of a Greek and of an Armenian archbishop, also of an admiralty board; and it contains a number of Greek and Armenian churches and convents, a catholic and a Lutheran church, a Hindu temple, several mosques, a botanic garden, three bazaars, a gymnasium, an ecclesiastical seminary, and several inferior schools. From its favourable position, it enjoys a very considerable trade both with the interior of Russia, and with India, Persia, &c. Besides its importance as a fishing station, it has considerable manufactures of cotton, silk, leather, &c. Lat. 46. 21. N. Long. 47. 55. E. Pop. in 1848 estimated at 50,000.

This city was anciently the capital of a kingdom belonging to the Tartars, who were expelled in 1554 by the Russian prince Iwan Basilowitz. In 1569 it was besieged by the Turks, but they were defeated with great slaughter by the Russians. In 1670 it was seized by the rebel Stenko Razin; but he was soon dispossessed of it by his uncle Jacolof, who remained faithful to the Czar. In 1702 and 1718 it suffered severely from conflagrations; and in 1830 the cholera swept away a great portion of its inhabitants.

ASTRÆA, in *Astronomy*, a name which some give to the sign Virgo, by others called *Erigone*, and sometimes *Isis*. The poets feign that Justice quitted heaven to reside on earth in the golden age; but growing weary of the iniquities of mankind, she left the earth and returned to heaven, where she took her place among the stars, and from her orb still looks down on the ways of men.

ASTRAGALOMANCY, a species of divination performed by throwing small pieces, with marks corresponding to the letters of the alphabet, the accidental disposition of which formed the answer required. This kind of divination was practised in a temple of Hercules in Achaia. The word is derived from ἀστράγαλος, and μαντεία.

ASTRINGENTS, a class of medicines which are used for binding or contracting the several parts, external or internal, of the human system, for restraining profuse discharges, coagulating the fluids, condensing and strengthening the solids. The principal astringents are the mineral acids, alum, lime-water, chalk, several preparations of copper, zinc, iron, &c., catechu, kino, oak-bark, galls, and all vegetable substances containing tannin.

ASTROLABE, a stereographic projection of the sphere, either on the plane of the equator, the eye being supposed to be in the pole of the world; or upon the plane of the meridian, when the eye is supposed in the point of the intersection of the equinoctial and horizon.

Astrolabe is also the name of an instrument formerly used for taking the altitude of the sun or stars at sea.

Astrolabe, among the ancients, was the same as our armillary sphere.

ASTROLOGY (from ἀστρόν and λόγος), a pretended science, teaching to judge of the effects and influences of the stars, and to foretell future events by the situation and different aspects of the heavenly bodies.

This science was divided into two branches, *natural* and *judiciary*. To the former belonged the predicting of natural effects; as the changes of weather, winds, storms, hurricanes, thunder, floods, earthquakes, &c. Judiciary or judicial astrology is that which pretended to foretell moral events, as if they were directed by the stars. It is commonly said to have been invented in Chaldea, and thence transmitted to the Egyptians, Greeks, and Romans; though some will have it of Egyptian origin. At Rome the people were so infatuated with it, that the astrologers, or, as they were then called, the *mathematicians*, maintained their ground in spite of all the edicts of the emperors to expel them from the city. The same superstition has prevailed in modern nations. The French historians tell us, that in the time of Queen Catherine dè'Medici, astrology was so much in vogue that the most inconsiderable thing was not to be done without consulting the stars. And in the reigns of King Henry III. and IV. of France, the predictions of astrologers were the common theme of the court conversation.

ASTRONOMY.

ASTRONOMY, from αστηρ or αστρον, *a star*, and νομος, *a law*, is the science which treats of the laws observed by the stars in their motions. By an extension of signification, it embraces every thing that is known relating to the nature and constitution, as well as to the motions, of the celestial bodies.

The present treatise is divided into Four Parts. In the *First*, which contains the History of Astronomy, the progressive advancement of the science from the times of the Chaldeans and Egyptians to the present day is briefly sketched, and the labours of those illustrious individuals commemorated, who have either theoretically or practically contributed most to its progress. The *Second Part*, which we have denominated Theoretical Astronomy, is devoted to a general view of the science,—to the explanation of the different theories and methods by which the motions of the celestial bodies are represented, and their places computed; and the description of such facts as observation has made known respecting their nature and constitution. *Part Third* treats of Physical Astronomy; and *Part Fourth* of Practicai Astronomy.

PART I.

HISTORY OF ASTRONOMY.

Astronomy, if we dignify by that name the first rude attempts that were made to discover the order and connection of the celestial motions, may probably be regarded as the most ancient of all the sciences. In fact, a certain degree of attention to the heavenly bodies is forced even on the savage who inhabits the forest, and derives his subsistence from the spontaneous productions of the earth. The regular vicissitude of day and night inevitably compels him to observe the diurnal course of the sun; and he cannot fail soon to perceive, that the variety and succession of the seasons is equally dependent on the oblique annual course of the same great luminary. The moon, too, in the absence of the sun, is an object so conspicuous, so consoling, and so useful, that her motions must at all times have been watched with attention and interest; while her various phases, her alternate waxings and wanings, her regular disappearance and return after equal intervals of time, would be contemplated with admiration and delight. Nor are the wonders of the starry firmament less calculated to strike even the most heedless observer of the heavens. The magnificent spectacle of the sky bespangled with brilliant points, and revolving in obedience to eternal and unalterable laws, affords a constant succession of new objects of sublime and exalted contemplation. The occasional recurrence, also, of eclipses and other unusual phenomena, which seem to interrupt the general order and uniformity of the celestial motions, would stimulate to attentive observation; for the vanity of man has in all ages rendered him eager to connect his own destiny with the heavens, while his timidity has prompted him to regard every apparent deviation from the ordinary course of events as an emblem of the wrath, and a precursor of the vengeance, of superior beings.

But though mankind were probably first impelled by motives of mere curiosity to observe the courses of the stars, no great length of time could elapse ere they perceived that the regular and uniform revolutions of the heavens might be rendered subservient to their own wants and conveniencies. By the help of the stars the shepherd, during the night, could count the hours, the traveller track his course through the uniform wastes of the desert, and the mariner guide his bark over the ocean: the husbandman, also, learned to regulate his labours by the appearance of certain constellations, which gave him warning of the approaching seasons. The indications derived from the simple observation of such phenomena were doubtless extremely vague; but as civilisation advanced, the necessity of determining accurately the length of the solar year and of the lunar month, in order to regulate the calendar and the religious festivals, led to the accumulation and comparison of different observations, whereby errors were gradually diminished, and the foundations laid of a more perfect acquaintance with the heavenly motions.

Astronomy, presenting so many objects of interesting curiosity, and having so many practical uses, could not fail to be one of the sciences first cultivated by mankind. Its origin is consequently hid amidst the obscurity and traditions of the remotest ages, and is in fact coeval with the origin of society, and the earliest development of the human intellect. The records or traditions of almost every ancient nation furnish some traces of attention to the state of the heavens, and of some rude attempts to discover the laws, the order, and the period of the most remarkable phenomena,—such as eclipses of the sun and moon, the motions of the planets, and the heliacal risings of the principal stars and constellations. The Chaldeans and Egyptians, Chinese and Indians, Gauls and Peruvians, equally regard themselves as the inventors of astronomy; an honour, however, of which Josephus deprives them all, in order to ascribe it to the antediluvian patriarchs. The fables relating to the two columns of brick and marble which these sages are said to have erected, and on which they engraved the elements of their astronomy, to preserve them from the universal destruction by fire and water to which, they are said to have learned from Adam, the earth was doomed, are not worth the trouble of repetition; nor is there any better proof than the assertion of that credulous historian, of their acquaintance with the *annus magnus*, or, as is most probably supposed, the astronomical cycle of 600 years, which brings back the sun and moon to the same points of the heavens so nearly, that its discovery implies a pretty correct knowledge of the solar and lunar motions. Passing over, therefore, those periods that present us only with a scanty detail of traditional observations or unimportant facts, we will proceed to give a brief account of the state of astronomy among some early nations who have undoubtedly contributed to the improvement of the science, or who, at least, have transmitted to future ages some monuments of their

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astronomical labours, and of their attention to celestial observations.

Astronomy of the Chaldeans, Egyptians, Phœnicians, Chinese, and Indians.

Chaldeans.

According to the unanimous testimony of the Greek historians, the earliest traces of astronomical science are to be met with among the Chaldeans and Egyptians. The spacious level and unclouded horizon of Chaldea afforded the utmost facilities for observing the celestial phenomena; and its inhabitants, enjoying the leisure afforded by a pastoral life, and stimulated by the vain desire of obtaining a knowledge of the future from the aspects of the stars, assiduously cultivated astronomy and astrology. By a long series of observations of eclipses, extending, according to the testimony of some authors, over nineteen centuries, or even a longer period, they had discovered the cycle of 223 lunations, or eighteen solar years, which, by bringing back the moon to nearly the same position with respect to her nodes, her perigee, and the sun, brings back the eclipses in the same order. This is supposed to be the period which they distinguished by the name of *Saros*. They had others, to which they gave the names of *Sossos* and *Neros;* but nothing positive is known with regard to their nature or extent. One thing only is certain, which is, that these Chaldaic periods, whatever they were, were founded on no theoretical knowledge of the celestial motions. They were purely empirical, detected by the comparison of recorded observations, and suppose neither theory nor science, unless, indeed, a simple arithmetical operation is to be considered as such; nor is there any reason to suppose that the Chaldeans employed any process of computation whatever in their predictions of eclipses. Having once established their cycle, they were in possession of a simple means of predicting all those which occurred in the course of it, with as great a degree of accuracy as they considered requisite.

The knowledge of these lunisolar periods among the Chaldeans is doubtless of great antiquity. Simplicius, the commentator of Aristotle, asserts that Callisthenes transmitted to Aristotle from Babylon a collection of observations of all the eclipses which had happened during the nineteen centuries that preceded the conquest of Alexander. This relation, however, is at variance with the accounts given by other historians. Epigenes, cited by Seneca and Pliny, who is supposed to have lived shortly before the time of Alexander, mentions observations of 730 years that had been found preserved on columns of brick. Ptolemy also makes mention of certain observations of eclipses that had been brought from Babylon, several of which he had calculated and verified; but the earliest of these ascends only to the year 720 before our era, or to the 26th of Nabonassar; and if either Hipparchus or himself had been acquainted with others of a more ancient date, they would doubtless have employed them in the determination of the mean motion of the moon. From this circumstance it appears probable that the Chaldeans had no observation sufficiently exact to be of any use to astronomy prior to the time of Nabonassar.

According to Apollonius of Myndus, the Chaldeans supposed the comets to be substances of the same nature as the planets; that they are visible only during a portion of their revolutions, and that they re-appear after certain intervals. But this statement, which argues some just notions respecting the celestial bodies, is contradicted by Epigenes, who himself studied among the Chaldeans, and who affirms, that instead of regarding the comets as subjected like the planets to the operation of eternal laws, they attributed their formation to vortices of inflamed matter, supposing them to have only a temporary existence, and to move in random directions through the fields of space. Diodorus says, that they regarded the world as eternal and imperishable, and held that its order is due, not to chance, but to a divine providence; that the planets, which have peculiar motions, announce future events by their various aspects and colours; that they portend rains, tempests, excessive heats; sometimes also the appearance of comets, eclipses, earthquakes, and, in short, whatever has a beneficial or hurtful influence on the fortunes of nations or individuals.

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From the few facts that can be gleaned from the vague accounts given by ancient authors of the astronomy of the ancient Chaldeans, it may be inferred that their boasted science was confined to observations of the simplest and rudest kind, neither guided by theory, nor assisted by instruments; for, notwithstanding the assertion of Herodotus, it is doubtful if they were acquainted even with the gnomon, the simplest of all instruments for determining the obliquity of the ecliptic, the altitude of the pole, and the length of the tropical year. If to the knowledge of their lunisolar periods, the result of ages of observation, we add the notion of a spherical revolution about an inclined axis, and an idea of the principal circles of the sphere and the position of the poles, the sum will comprehend all that constituted the science of a people regarded by antiquity as having made the greatest progress in the science of the stars. Astronomy, however, owes some obligations to their humble labours. The observations which they recorded served to correct the theories that were afterwards imagined by the more brilliant genius of the Greeks, and thereby furnished some materials for the edifice of the world.

Egyptians

The Egyptians were in ancient times the rivals of the Chaldeans in the cultivation of astronomy; and although they have left behind them still fewer monuments of their labours, they have obtained, through the exaggerated statements of the Greeks, even a greater reputation. The Greeks acknowledge themselves indebted to the Egyptians for their science and civilisation; but regarding themselves likewise as descendants of that ancient people, they indulged their vain-glory in magnifying the accounts of the antiquity and knowledge of their supposed ancestors. It is not improbable that some traditional observations of the heavens, along with some arts indispensable to society even in its earliest stages, were carried into Europe by tribes migrating from the banks of the Nile; and it is certain that the early philosophers of Greece travelled into Egypt for the purpose of acquiring a more perfect knowledge of astronomy than could be obtained in their own country. But the facts from which it can be inferred that the Egyptians had much to communicate, are few and ill attested. They are also blended with so much absurdity and fable, that no accurate notions can be formed, from the accounts that have been transmitted to us, of the real advances which that people had made in astronomical science. The priests were the depositaries of the national knowledge; and they carefully concealed it from the vulgar by shrouding it in allegories, traces of which, it has been remarked, may be detected in the institutions even of the present day.

According to Diogenes Laertius, the Egyptians reckoned 48,853 years from Vulcan to Alexander, during which they had observed 373 eclipses of the sun, and 832 of the moon. These numbers in fact nearly express the relative proportion of the eclipses of the two luminaries; but the enormous length of the period altogether exceeds

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From this brief account it appears, that the only circumstances with which we are acquainted that imply the knowledge of astronomical methods among the Egyptians, are the length of the year, the doubtful discovery of the true motions of Mercury and Venus, and the position of the pyramids. The Chaldean observations were of use to Hipparchus and Ptolemy in the determination of some important elements; but those of the Egyptians exercised no influence whatever on the future progress of the science.

Phœnicians. The Phœnicians are also generally enumerated among the nations who cultivated astronomy at a very early period, though it does not appear, from any facts mentioned by ancient authors, that they addicted themselves to the observation of the heavens, or made any discoveries relative to the motions of the planets. That they excelled in the art of navigation is certain, from the commercial intercourse which they carried on with many places on the coasts of Africa and Spain, and in the principal islands of the Mediterranean; and it may readily be allowed that in their long voyages they would direct their course during the night by the circumpolar stars. If they had any speculative notions of astronomy, these were probably derived from the Chaldeans or Egyptians.

Chinese. In China, astronomy has been cultivated from the remotest ages, and always been considered as a science indispensably necessary to the civil government of the state. The Chinese boast of a series of eclipses, recorded in the annals of the nation, extending over a period of 3858 years, all of which, they pretend, were not only carefully observed, but calculated and figured previous to their occurrence. The same motives which led the Chaldeans and Egyptians to attend to the celestial phenomena, namely, the regulation and division of time, had equal influence among the Chinese; and we accordingly find the care of the calendar occupying the attention of their earliest princes. The emperor Fou-Hi, whose reign commenced about 2857 years before our era, is said to have assiduously studied the motions of the celestial bodies, and laboured to instruct his ignorant subjects in the mysteries of astronomy. But as they were yet in too rude a condition to be able to comprehend his theories, he was obliged to content himself with giving them a rule for the computation of time by means of the numbers 10 and 12, the combination of which produces the cycle of 60 years, which is the standard or unit from which they deduce their hours, days, and months. Tradition is silent with respect to the sources from which Fou-Hi derived his own knowledge. The Chinese attribute to him also the invention of arithmetic and music. In the year 2608 B. C., Hoang-Ti caused an observatory to be built, for the purpose of correcting the calendar, which had already fallen into great confusion, and appointed one set of astronomers to observe the course of the sun, another that of the moon, and a third that of the stars. It was then discovered that the twelve lunar months do not exactly correspond with a solar year; and that, in order to restore the coincidence, it was necessary to intercalate seven lunations in the space of nineteen years. If this fact rested on undoubted evidence, it would follow that the Chinese had anticipated the Greeks by 2000 years in the discovery of the Metonic cycle. The reign of Hoang-Ti is also rendered memorable by the institution of the *Mathematical Tribunal*, for promoting the science of

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astronomy, and regularly predicting eclipses, to which an extraordinary importance has always been attached in China. The members of this celebrated tribunal were made responsible with their lives for the accuracy of their predictions, by a law of the empire, which ordained that, " whether the instant of the occurrence of any celestial phenomenon was erroneously assigned, or the phenomenon itself not foreseen and predicted, either negligence should be punished with death." In the reign of Tchong-Kang, the two mathematicians of the empire, Ho and Hi, were the victims of this absurd and sanguinary law; an eclipse having taken place which their skill had not enabled them to foresee.

The emperor Yao, who mounted the throne, according to the Chinese annals, about the year 2317 B. C., gave a new impulse to the study of astronomy, which had begun already to decline. He ordered his astronomers to observe with the utmost care the motions of the sun and moon, of the planets and the stars, and to determine the exact length of each of the four seasons. He sent Hi-Tchong to the east to observe the star situated at the point of the vernal equinox, Hi-Tchou to the south to examine that at the summer solstice, Ho-Tchong to the west, and Ho-Tchou to the north, to observe those situated respectively at the autumnal equinox and winter solstice. These docile observers found stars in the positions assigned by the emperor; but the extraordinary resemblance of their names imparts a fabulous air to the whole relation, and excites a very excusable incredulity even with regard to those statements which involve no improbability. To this emperor are attributed the Chinese division of the zodiac into 28 constellations, called the houses of the moon, and the severe laws already noticed in regard to the erroneous prediction of the celestial phenomena.

From the time of Yao the Chinese year consisted of $365\frac{1}{4}$ days. They also divided the circle into $365\frac{1}{4}$ degrees, so that the sun daily described in his orbit an arc of one Chinese degree. Their common lunar year consisted of $364\frac{448}{940}$ days; and by combining this number with $365\frac{1}{4}$, they formed the period of 4617 years, after which the sun and moon again occupy the same relative positions.

The earliest Chinese observations we are acquainted with, sufficiently precise to afford any result useful to astronomy, were made by Tcheou-Kong, whose reign commenced about the year 1100 before our era. Two of these observations are meridional altitudes of the sun, observed with great care at the village of Loyang, at the time of the summer and winter solstices. The obliquity of the ecliptic thus determined at that remote epoch is $23° 54' 3{\cdot}15''$; a result which perfectly agrees with the theory of universal gravitation. Another observation, made about the same time, relates to the position of the winter solstice in the heavens; and it also corresponds to within a minute of a degree with the calculations of Laplace. Laplace considers this extraordinary conformity as an indubitable proof of the authenticity of those ancient observations.

The golden age of Chinese astronomy extended from the reign of Fou-Hi to the year 480 B. C.; that is, over a space of 2500 years. It is only, however, towards the latter part of this long period that the history of China becomes in any degree authentic; and the true date which must be assigned for the commencement of observations on which any reliance can be placed, is the year 722 B. C.; that is, 25 years posterior to the era of Nabonassar. From that period to the year 400 B C. Confucius reckons a series of 36 eclipses, and of these 31 have been verified by modern astronomers. After this the science fell into great neglect, notwithstanding the inveterate tenacity with which the Chinese in general adhere to their ancient customs. The decline of their astronomy is ascribed, whether justly or not, to the barbarous policy of the emperor Tsin-Chi-Hong-Ti, who, in the year 221 B. C., ordered all the books to be destroyed, excepting those only which related to agriculture, medicine, and astrology, the only sciences which he considered as being of any use to mankind. His fury, it is true, was principally directed against those of Confucius, the stern morality of which he felt to be a censure on his own profligacy; but those of science and astronomy were included in the general destruction. In this manner, it is said, the precious mass of astronomical observations and precepts which had been accumulating for ages was irretrievably lost.

Lieou-Pang, the successor of Tsin-Chi-Hong, endeavoured to repair the disaster, by re-establishing the tribunal of the mathematics, and ordering a new series of observations to be undertaken. About the year 104 B. C. the astronomer Sse-Ma-Tsien gave some precepts for the calculation of eclipses, the motions of the planets, and the syzygies. He employed instruments of copper, the nature and construction of which are however not very well understood, for measuring the extent of the 28 zodiacal constellations; and he observed the meridional altitudes of the sun, by means of a gnomon 8 feet high. The differences of right ascensions, and the intervals between the risings, settings, and culminations of the stars, were measured by clepsydræ. It would appear that after this period astronomical observations continued for some time to be made in China with considerable regularity. In the 164th year of our era the astronomer Tchang-Heng constructed armillary spheres and a celestial globe. He also formed a catalogue of stars, which is said to have contained 2500, but without either latitudes or longitudes; a circumstance which gives us a very unfavourable idea of the state of practical astronomy at that time. About the eighth century of our era, all knowledge of the science seems to have been again lost. The predictions were erroneous; and the Chinese witnessed, with superstitious terror, eclipses of which their astronomers had given them no intimation. This induced the emperor Hieng-Tsong to call to his court the astronomer Y-Hang, by whose indefatigable activity a reform was speedily effected. With a view to determine the situations of the principal places of the empire, this astronomer constructed gnomons, spheres, astrolabes, quadrants, and other instruments; and sent one company of mathematicians to the south, and another to the north, with directions to observe daily the altitudes of the sun and the polar star. The latitudes of the cities were determined by observing the shadow of the gnomon, and the longitudes by eclipses of the moon. Y-Hang had the mortification of announcing two eclipses which did not take place. On these occasions he alleged the usual excuse, namely, that his calculus was not in error, but that the celestial bodies had deviated from their ordinary courses out of respect to the virtues of the emperor. The fate of Ho and Hi had probably suggested to the Chinese astronomers this ingenious mode of disarming the emperor's resentment by flattering his vanity.

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On considering attentively the accounts which have been given of the Chinese astronomy, we find that it consisted only in the practice of observations which led to nothing more than the knowledge of a few isolated facts. The missionaries who were sent out by the Jesuits about the end of the seventeenth century, to whom we are indebted for what is known of the early history

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of China, either seduced by some appearances of truth, or thinking it prudent to conciliate the people whom they were attempting to convert, adopted their marvellous relations regarding the antiquity of their science, and spread them over Europe. As the history of the nation begins to become more authentic, their astronomy shrinks into its real but insignificant dimensions. Superstitiously attached to their ancient usages, and blindly adopting the habits of their ancestors, the Chinese continued to observe the heavens from century to century without making the slightest advances in theoretical knowledge. In later times they have adopted many improvements, for which they are entirely indebted to foreigners. During the time of the caliphs many Mahometans passed into China, carrying with them the astronomical methods and knowledge of the Arabians. The missionaries introduced the science of Europe; and the most that can be said in praise of the Chinese is, that their government sometimes relaxed so far its spirit of jealousy and exclusion, as to afford protection to these strangers, adopt their arts, and place them at the head of the mathematical tribunal.

Indians.

The astronomy of the Indians forms one of the most curious problems which the history of science presents to the consideration of the learned, and one which, notwithstanding the numerous dissertations to which it has given rise, still continues involved in great uncertainty. Of the science of the ancient nations, of which we have already spoken, the accounts which have come down to our times are founded on conjecture and tradition; for few monuments remain to confirm or confute the glowing descriptions which authors have given of its high antiquity and great perfection. But the claims of the Indians rest on more solid foundations. We are in possession of the tables from which they compute the eclipses and places of the planets, and of the methods by which they effect the computation: we have, in short, an Indian astronomy committed to writing, which represents the celestial phenomena with considerable exactness, and which, therefore, could only be produced by a people far advanced in science. But the difficulty of the problem consists in determining the sources from which this science originated, and the epoch of its existence; whether it was created by the people who now blindly follow its precepts without understanding its principles, or was communicated to them by another race of a bolder and more original genius, through channels with which we are unacquainted. Some authors regard India as the cradle of all the sciences, particularly of astronomy, which they suppose to have been cultivated there from the remotest ages; others date the origin of the Indian astronomy from the period when Pythagoras travelled into that country, and carried thither the arts and sciences of the Greeks; a third opinion is, that astronomy was conveyed to India by the Arabians in the ninth century of our era, and that the Brahmins are only entitled to the humble merit of adapting the rules and practices of that people to their own peculiar methods of calculation. We shall endeavour to describe very briefly the existing monuments of the Indian astronomy, which furnish the only data from which a rational conjecture can be formed relative to its antiquity and precision.

We possess four different sets of tables of Indian astronomy. The first which were known in Europe were brought from Siam by La Loubère, who had resided in that country as ambassador from Louis XIV. They were communicated by him to the celebrated Cassini, who, notwithstanding the difficulties arising from the complicated and useless operations which they directed, succeeded in detecting the principles on which they were constructed, and in explaining their use and signification. The date of these tables corresponds to the 21st of March in the year 638 of our era. They suppose two species of years, the solar tropical year, which they make to consist of 365 days 5 hours 50 min. and 4 sec., and the solar anomalistic year, that is, the period in which the sun returns to its apogee, which they estimate at 365 days 6 hours 12 min. 36 sec. This determination of the length of the solar year is too great only by 1 min. 15 sec. By means of the same tables the longitudes of the sun and moon are determined with considerable accuracy. They contain a correction for the sun's mean place, which corresponds to the equation of the centre. At 90° from the apogee, where the inequality of the sun's motion is greatest, they estimate the requisite correction at 2° 12′, which is about 16′ too great. This determination deserves to be particularly remarked, because, on account of a secular inequality of the eccentricity of the sun's orbit, there was once a time when the greatest value of the equation of the centre was nearly 2° 12′; and this fact is adduced as a proof of the remote antiquity of the observations from which the tables in question have been constructed. These tables suppose the apogee to retain always the same position relatively to the fixed stars; in reality it advances or gains on the stars about 10″ annually; but the supposition is still much nearer the truth than in the system of Ptolemy, where the apogee is supposed to be absolutely at rest with regard to the plane of the sun's orbit, and consequently to fall back among the stars by the whole quantity of the precession of the equinoxes, or about 50″ annually. With regard to the motions of the moon, they are deduced from a period of 19 years, in which are comprehended nearly 235 lunations; so that the cycle of Meton appears to have been known in Siam as well as in China. The moon's apogee is supposed to have been in the beginning of the movable zodiac 621 days after the epoch of the 21st of March 638, and to make an entire revolution in the heavens in the space of 3232 days. The first of these suppositions agrees with Mayer's tables to within a degree, and the second differs from them only by 11 hours 14 min. 31 sec. They contain only one correction for the two principal inequalities of the moon's motion, the equation of the centre and the evection.

A second set of Indian tables was sent from Chrisnabouram, a town in the Carnatic, by Father Du Champ, to De Lisle, about the year 1750. They are fifteen in number. They give the mean motions of the sun, moon, and planets; equations of the centre for the sun and moon; and two corrections for each of the planets, one of which corresponds to the apparent, the other to the real inequality. The epoch of these tables is not so ancient as that of the former. It corresponds to the 10th of March, at sunrise, in the year 1491 of our era, when the sun and moon were in conjunction.

A third set of astronomical tables was sent from India by Father Patonillet, and received by De Lisle about the same time with those of Chrisnabouram. These have not the name of any particular place affixed to them; but being calculated for the latitude of 16° 16′, Bailly thinks it probable that they came from Narsapour. Their epoch is midnight, between the 17th and 18th of March 1569.

The fourth and last set of Indian tables which we possess have been published in the Memoirs of the Academy of Sciences. They were communicated by a learned Brahmin of Tirvalore, a small town on the Coromandel coast, to the French astronomer Legentil, who had gone to India to observe the transit of Venus in 1769. The tables

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of Tirvalore, though somewhat different in form, present many points of resemblance with those formerly known in Europe. They suppose the same length of the year, the same inequalities of the sun and moon, and they are adapted nearly to the same meridian. But while they correspond with the other tables in these elements, they differ from them greatly in the antiquity of their epoch, which goes back to the famous era of the Calyougham, that is, the beginning of the year 3102 before Christ.

Now, the only question to be determined with regard to the antiquity of the Indian astronomy is, whether this epoch is real or fictitious; that is, whether the state of the heavens at the commencement of the Calyougham, as assumed in these tables, was actually determined by observation, or computed backwards from observations of more modern date. The solution to this question can only be obtained from the internal evidence afforded by the tables themselves; by examining whether the elements and precepts which they furnish are of sufficient accuracy to enable the places of the sun, moon, and planets to be calculated through a period of 44 centuries, without involving errors which the refined accuracy of the modern tables furnishes the means of detecting. A comparison of the Indian with the modern tables has been made at great length by Bailly, who imagines that he finds ample evidence of the reality of the era in question, and of the existence of an astronomy prior to that period, hardly yielding in accuracy to that which modern science has built on the theory of universal gravitation. The theory of Bailly has been adopted, and put forth with additional clearness and evidence, by the late Professor Playfair. One of the principal arguments which these illustrious authors bring forward in support of it is founded on the longitudes of the sun and moon. The mean place of the moon at the commencement of the Calyougham, that is, at midnight, between the 17th and 18th of February 3102 B. C., is stated by the Indian tables to be 306°. Her mean place, computed from Mayer's tables, without taking into account the acceleration, with which the Indians in the 15th century were of course unacquainted, is 300° 51′ 16″. Hence there would be a discrepancy of 5° 8′ 44″. But, according to the theory and last tables of Laplace, the moon, in virtue of the acceleration of her mean motion, has passed over an arc of very nearly 6° more than she would have done had her mean motion continued uniform from the period of the Calyougham to the date of Mayer's tables. This added to 300° 51′ 16″ gives 306° 51′ 16″ for the mean longitude of the moon at the epoch of the Calyougham, differing from the Indian determination by only 51′ 16″. Now, it is argued that this is a degree of accuracy which could have been reached only by actual observation, especially since, if the tables had been computed backwards, the error arising from the acceleration alone would have amounted to more than 5°. Bailly computes the place of the moon at the same epoch, from all the tables, Greek and Arabian, to which the Indians can be supposed to have had access, and the discrepancies are so great as to render his conclusion almost inevitable, that the Indian tables could not possibly have been drawn from such sources. The tables of Ptolemy make the moon's longitude at that time 11° 52′ 7″ greater than the Indian tables; and those of Ulugh-Beigh, constructed at Samarcand in 1437, give a difference of 6° also in excess.

Similar results are obtained from the consideration of other elements. According to the tables of Tirvalore, the tropical year consists of 365 days 5 hours 50 min. 35. sec. Lacaille makes it 365 days 5 hours 48 min. 49 sec. The difference is 1 min. 46 sec. Now the tropical year, being affected by the precession of the equinoxes, is subject to a secular inequality, which, according to the theory of Lagrange, renders it actually shorter by 40·5 sec. at the present time than it was at the commencement of the Calyougham. The error of the Indian tables is thus reduced to 1 min. 5·5 sec. In like manner, the obliquity of the ecliptic, which has been gradually diminishing during a great number of centuries, is supposed in the Indian tables to be greater than it is now found to be by observation. The Brahmins estimate it at 24°. The formula of Lagrange makes the variation, in 4800 years, amount to 22′ 32″. This therefore must be added to its obliquity in 1700, that is, to 23° 28′ 41″, in order to have the true obliquity at the commencement of the Calyougham. The sum is 23° 51′ 13″, and falls short of the Indian determination by 8′ 47″. We shall mention only another element, the equation of the centre of the sun. Bailly calculates that, according to the theory of Lagrange, the equation of the sun's centre, at the epoch of the tables, was 2° 6′ 28″. The Indians make it 2° 10′ 32″. The difference is only about 4′, and incomparably less than could have resulted from calculation by any methods which we can suppose the Indians to have possessed.

These arguments, it must be admitted, are exceedingly specious, but they are not by any means convincing. Even with the best modern tables we could not, as Bailly himself acknowledges, answer for the accuracy of the places of the sun and moon computed for so remote an epoch. The corrections for the secular inequalities amount in that long period to considerable quantities; and these corrections are deduced by theory from elements with respect to which there exists great uncertainty. And if we cannot be sure of the true places by computing backwards from our own tables, with what degree of confidence can we pronounce upon the accuracy of the places assigned in the tables of the Indians? It may be said that comparisons of this kind can never be supposed to give results perfectly alike. Granted: but if the discrepancies are such that the lapse of a thousand years more or less is required to establish a rigorous conformity, what becomes of the famous epoch of the Calyougham? Some of the elements of the Indian tables could not have the values assigned to them but at a long period before that epoch. In order to find their equation of the sun's centre, for example, it is necessary, according to the results of modern theory, to go back to 6000 years before our era. The argument, therefore, proves too much, and is consequently inconclusive. The different sets of tables of which we have spoken are closely allied with each other, and the most probable supposition is, that they are all derived from those of Chrisnabouram, of which the epoch is 1491. At that era the Indians were acquainted with the instruments, the geometry, and the researches of the Arabians and Greeks. Through this channel the tables seem to have come into their possession. The Brahmins adapted them to their own particular methods of computation, and threw back their epoch to the period when, according to these tables, all the planets were in conjunction with the sun. Every circumstance connected with the science of the Indians conspires to give us the humblest ideas of its value. Their methods of computation are encumbered with the unnecessary multiplications and divisions of enormous numbers, endless additions, subtractions, and reductions, for the purpose of obtaining numbers which could be put into technical verses, and even adapted to songs; so that the astronomer might be enabled to effect his calculations from memory alone, without its being necessary to have

recourse to tables or books. But simple and rude as these methods are, if they were really invented by the Brahmins, the science of that people must have greatly retrograded; for at present they merely follow a blind routine, utterly ignorant of theory, or the principles on which their processes are founded. Their astronomy, whether of ancient or recent origin, has produced no effect whatever on that of Europe; it has no filiation or connection with the science of the present day, and therefore has no other claim on our attention than such as may result from motives of mere curiosity.[1]

Astronomy of the Greeks.

The origin of astronomy in Greece, as in other early nations, ascends beyond the period of authentic history, and is concealed amidst the fables and traditions of the remotest times. During the darkness of the heroic ages some gleams of an acquaintance with the motions of the stars occasionally burst forth; and some traces appear of astronomical observations, probably derived from Egypt, the country which also furnished Greece with its gods and its arts. The Greeks seem to have divided the heavens into constellations about 13 or 14 centuries before the Christian era; for the sphere of Eudoxus, which is probably one of the fruits of the famous voyage of the Argonauts, must be referred to that period. Their early attention to the appearances of the heavens is sufficiently attested by their mythological fables, the greater part of which are only allegories of the celestial motions, and of the operations of nature. The lively fancy and brilliant imagination of this ingenious people strewed flowers in the most rugged paths, and spread agreeable images over the driest and most uninviting subjects: hence the sky was quickly covered with legends of the loves and exploits of gods and heroes. It would be foreign to our present purpose to enter into an enumeration of these fables, or attempt to trace their connection with the first dawnings of astronomy: we shall content ourselves with barely alluding to Uranus, to Atlas and his son Hesperus, who gave his name to the planet Venus; also to his daughters the Atlantides, from whom the Pleiades received their appellation; to Endymion, who, on the summit of Mount Latmos, held nocturnal converse with the chaste Diana; to Hercules; and Chiron the centaur, who taught men the use of the constellations; Musæus, who imagined the figures of men and animals which cover the celestial sphere; Orpheus and Linus, who explained the theogonies; Atreus, from whose banquet the sun fled back with horror; and Tiresias, who was struck blind for having witnessed some secret of the gods.

Thales, born 640 B.C.

The true foundations of Grecian science were laid by Thales, who was born at Miletus 640 years before our era. He was descended from an illustrious family, which had formerly reigned in Phœnicia, and inherited an ample fortune, which he expended in collecting the expiring embers of oriental science. Instigated by the love of knowledge, he travelled first into Crete, and afterwards into Egypt, where he was initiated into the mysteries of the priests, to whom, in return, he is said to have taught the method of measuring the height of the pyramids by comparing their shadows with those of known objects. Returned to his own country, he publicly taught the truths he had collected during his travels, and formed a sect which has been distinguished by the title of the *Ionian School.* His doctrines regarding astronomy contain a few truths which do honour to his sagacity and observation, though they are mixed with much error and absurdity. He taught that the stars are formed of fire; that the moon receives her light from the sun, and is invisible at her conjunctions, because she is hid in the sun's rays. He also taught the sphericity of the earth, which he placed at the centre of the world. He divided the sphere into five zones, by the arctic and antarctic circles, and the two tropics; and held that the equator is cut obliquely by the ecliptic, and perpendicularly by the meridian. He is also said to have observed eclipses; and Herodotus relates that he predicted the famous one which put a stop to the war between the Medes and the Lydians. It does not appear, however, that he ventured to assign either the day or the month of the eclipse, so that his prediction must have been confined to the year. According to Callimachus, he determined the positions of the stars which form the Lesser Bear, by which the Phœnicians guided themselves in their voyages. It is difficult, however, to conceive how Thales, unacquainted with instruments, could determine the positions of stars with so much accuracy as to render any essential assistance to the navigator. It is probable that he only pointed out the configuration, and some of the more brilliant stars of that constellation, among which he might remark that which is nearest the pole of the world.

Anaximander, born 610 B.C.

Thales was succeeded by Anaximander, to whom is also attributed the invention of the sphere, and the knowledge of the zodiac. According to Diogenes Laertius, he supposed, like his master Thales, the earth to be spherical, and placed at the centre of the universe; but Plutarch ascribes to him the less philosophical opinion of its resemblance to a column. He supposed the sun to be of equal magnitude with the earth. He invented the gnomon, and placed one at Lacedæmon to observe the solstices and equinoxes. But the circumstance which does most honour to Anaximander, and which entitles him to the gratitude of posterity, is the invention of geographical charts. He is said also to have believed in the plurality of worlds,—a sublime idea, which was adopted by almost every succeeding philosopher of Greece.

Anaximenes, born 530 B.C.

Anaximenes succeeded Anaximander in the Ionian school, and maintained nearly the same doctrines. Pliny says he was the first who taught the art of constructing dials,—an invention which, as we have just seen, has also been ascribed to Anaximander. These two philosophers probably revived the knowledge of an instrument the use of which had been forgotten amidst the general rudeness and ignorance of their countrymen. Before their time the Greeks only marked the divisions of the day by the different lengths of the sun's shadow.

Anaxagoras, born 500 B.C.

Anaxagoras was the disciple and successor of Anaximenes. If this philosopher really entertained the ridiculous opinions ascribed to him by Plutarch, the Ionian school must rather have retrograded than advanced in sound philosophy from the time of Thales. He is said to have believed that the sun is a mass of red-hot iron, or of heated stone, somewhat bigger than the Peloponnesus,—that the heaven is a vault of stones, which is prevented from tumbling only by the rapidity of its circular motion,—and that the sun is prevented from advancing beyond the tropics by a thick and dense atmosphere, which forces

[1] For an account of the Indian astronomy, see Bailly, *Astronomie Indienne;* also a Memoir by Professor Playfair, in the *Edinburgh Transactions*, vol. ii., or in the 3d volume of his Works; and the Papers of Jones, Bently, and Davis, in the *Calcutta Memoirs.* The theory of Bailly is most satisfactorily refuted by Delambre. See his *Histoire de l'Astronomie Ancienne*, tom. i

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him to retrace his course. These absurd notions are probably greatly exaggerated; but it does not appear that Anaxagoras contributed much to extend the knowledge of the heavens. A melancholy interest is, however, excited in his behalf, on account of the persecution which he suffered in consequence of his liberal opinions and his disregard for the superstitious notions of his age. Having shown the reason of the eclipses of the moon, he was accused of ascribing to natural causes the attributes and power of the gods. Having taught the existence of only one God, he was accused of impiety and treason towards his country. Sentence of death was pronounced on the philosopher and all his family; and it required the powerful interest of his friend and disciple Pericles to obtain a commutation of this iniquitous sentence into one of perpetual banishment.

Pythagoras, born 580 B.C.

While the Ionian sect was so successfully employed in cultivating and propagating a knowledge of nature in Greece, another, still more celebrated, was founded in Italy by Pythagoras. This renowned philosopher was in early youth a disciple of Thales. In quest of knowledge, which in those days could only be obtained by visiting the sages of foreign lands, he travelled into Egypt, Phœnicia, Chaldea, and India, where his memory is said still to subsist. Through the favour of Amadis, king of Egypt, to whom he was recommended by Polycrates, the tyrant of Samos, he was admitted into the sacred college at Memphis, though with great reluctance on the part of the priests. The severe ordeal through which these charlatans compelled him to pass, before they would consent to initiate him into their mysteries, was sufficient to have deterred the most courageous votary of knowledge; and Pythagoras was probably the only stranger who ever succeeded in fully exploring their secrets. After an absence of thirty years he returned to Greece, and began to give instructions in his native island of Samos. Soon after, he passed over to the Grecian colony established at Tarentum in Italy, and settled at Crotona, where he speedily acquired a splendid reputation. He was the first who assumed the modest title of *philosopher*, or lover of wisdom: formerly those who devoted themselves to the acquisition of learning were called *sophists* or *sages*.

Pythagoras is said to have acquired in Egypt the knowledge of the obliquity of the ecliptic, and that of the identity of the morning and evening stars. What he chiefly deserves to be commemorated for in the history of astronomy, is his philosophical doctrine regarding the motion of the earth. He taught publicly that the earth is placed at the centre of the universe; but among his chosen disciples he propagated the doctrine that the sun occupies the centre of the planetary world, and that the earth is a planet circulating about the sun. This system, which still retains his name, being called the old or Pythagorean system of the universe, is that which was revived by Copernicus. It is, however, only just to the memory of this last mentioned great man to observe, that there is a vast difference between the bare statement of the possibility of a fact, and the demonstration of its existence by irrefragable arguments. Pythagoras having remarked the relation which subsists between the tone of a musical chord and the rapidity of its vibration, was led by analogy to extend the same relation to the planets, and to suppose that they emit sounds proportional to their respective distances, and form a celestial concert too melodious to affect the gross organs of mankind. Another fancy into which he was led by his passion for analogies, was the application of the five geometrical solids to the elements of the world. The cube symbolically represented the earth; the pyramid, fire; the octaedron, air; the icosaedron, or twenty-sided figure, water; and the dodecaedron, or figure with twelve faces, the exterior sphere of the universe. Pythagoras left no writings; and it is doubtful whether he really entertained many of the opinions and reveries which have usually been ascribed to him.

Philolaus.

Philolaus of Crotona, a disciple of Pythagoras, embraced the doctrine of his master with regard to the revolution of the earth about the sun. He supposed the sun to be a disk of glass which reflects the light of the world. He made the lunar month consist of $29\frac{1}{2}$ days, the lunar year of 354 days, and the solar year of $365\frac{1}{2}$ days.

Nicetas.

Nicetas of Syracuse seems to have been the first who openly taught the Pythagorean system of the universe. Cicero, on the authority of Theophrastus, the ancient historian of astronomy, gives him the credit of maintaining that the apparent motion of the stars arises from the diurnal motion of the earth about its axis;[1] but this rational doctrine seems to have been first broached by Heraclides of Pontus, and Ecphantus, a disciple of Pythagoras.

Metonic cycle, 433 B.C.

The introduction of the Metonic cycle forms an era in the history of the early astronomy of Greece. The Chaldeans, as we have already stated, established several luni-solar periods; and the difficulty of reconciling the motions of the sun and moon, or of assigning a period at the end of which these two luminaries again occupy the same positions relatively to the stars, had long embarrassed those who had the care of regulating the festivals. Meton and Euctemon had the honour of first obviating this difficulty, at least for a time; for the motions of the sun and moon being incommensurable, no period can be assigned which will bring them back to precisely the same situations. These two astronomers formed a cycle of nineteen lunar years, twelve of which contained each 12 lunations, and the seven others each 13, which they intercalated among the former. It had long been known that the synodic month consisted of $29\frac{1}{2}$ days nearly; and in order to avoid the fraction, it had been usual to make the twelve synodic months, which compose the solar year, to consist of 29 and 30 days alternately; the former being called *deficient* and the latter *full* months. Meton made his period to consist of 125 full and 110 deficient months, which gives 6940 days for the 235 lunations, and is nearly equal to 19 solar years. This cycle commenced on the 16th of July in the year 433 B.C. It was received with acclamation by the people assembled at the Olympic games, and adopted in all the cities and colonies of Greece. It was also engraved in golden letters on tables of brass, whence it received the appellation of the *golden number*, and has been the basis of the calendars of all the nations of modern Europe. It is still in ecclesiastical use, with such modifications as time has rendered necessary.

Eudoxus 370 B.C.

Eudoxus of Cnidus, about the year 370 B.C., obtained great reputation as an astronomer. According to Pliny, he introduced the year of $365\frac{1}{4}$ days into Greece. Archimedes says that he supposed the diameter of the sun to be nine times greater than that of the moon, which shows that he had in some degree overcome the illusions

[1] "Nicetas Syracusius, ut ait Theophrastus, cœlum, solem, lunam, stellas, supera denique omnia, stare censet; neque, præter terram, rem ullam in mundo moveri; quæ cum circum axem se summa celeritate convertat et torqueat, eadem effici omnia, quasi, stante terra, cœlum moveretur." (Cicero, *Acad. Quæst.*; *Opera*, tom. iv. p. 39, edit. Bipont.) Copernicus himself could not have stated the doctrine with greater precision.

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of sense. The titles of three of his works have been preserved—the *Period or Circumference of the Earth*, the *Phenomena*, and the *Mirror*. His observatory was still standing at Cnidus in the time of Strabo. His memory deserves to be honoured for the contempt which he evinced for the Chaldean predictions, and for having contributed to separate true astronomy from the reveries of judicial astrology. Eudoxus seems to have been the first who attempted to give a mechanical explanation of the apparent motions of the planets. He supposed each planet to occupy a particular part of the heavens, and that the path which it describes is determined by the combined motion of several spheres performed in different directions. The sun and moon had each three spheres; one revolving round an axis which passes through the poles of the world, and which occasions the diurnal motion; a second revolving round the poles of the ecliptic, in a contrary direction, and causing the annual and monthly revolutions; the third revolving in a direction perpendicular to the first, and causing the changes of declination. Each of the planets had a fourth sphere to explain the stations and retrogradations. As new inequalities and motions were discovered, new spheres were added, till the machinery became so complicated as to be altogether unintelligible.

Plato.

Although Plato can hardly be cited as an astronomer, yet the progress of the science was accelerated by means of the lights struck out by his sublime and penetrating genius. He seems to have had just notions of the causes of eclipses; and he imagined that the celestial bodies originally moved in straight lines, but that gravity altered their directions, and compelled them to move in curves. He proposed to astronomers the problem of representing the courses of the stars and planets by circular and regular motions. Geometry was assiduously cultivated in the school of Plato; and on this account he claims a distinguished place among the promoters of true astronomy.

Aristotle, born 384, died 321, B.C.

Astronomy is also under some obligations to Aristotle. In a treatise which he composed on this science, he recorded a number of observations which he had made; and, among others, mentions an eclipse of Mars by the moon, and the occultation of a star in the constellation Gemini by the planet Jupiter. As such phenomena are of rare occurrence, their observation proves that he had paid considerable attention to the planetary motions.

A great number of astronomers about this time appear on the stage, whose labours and observations prepared the way for the reformation of the science which was shortly after effected by Hipparchus.

Helicon.

Helicon of Cizicene is renowned for the prediction of an eclipse, which took place, as Plutarch affirms, at the time announced. History records the names of only three individuals in ancient Greece who predicted eclipses, Thales, Helicon, and Eudemus.

Eudemus.

Eudemus composed a history of astronomy, a fragment of which, consisting of only a few lines, is preserved by Fabricius in the *Bibliotheca Græca*. In this it is mentioned that the axes of the ecliptic and equator are separated from each other by the side of a pentedecagon, which is equivalent to saying that they contain an angle of 24°. This is the first value which we find assigned by the Greeks to the obliquity of the ecliptic. It is given in round numbers, and may easily be supposed to contain an error of a quarter of a degree.

Calippus.

Calippus is celebrated for the period which he formed of four Metonic cycles. Having observed, by means of an eclipse of the moon which took place about six years before the death of Alexander, that the Metonic cycle contained an error of a fourth of a day, he introduced the period of 940 lunations, containing four Metonic cycles, diminished by one day. He likewise formed a collection of observations on the heliacal risings of the planets.

Theophrastus.

Theophrastus wrote a history of astronomy, and supposed the milky way to be produced by the imperfect junction of the two hemispheres, which allowed the light to penetrate from the firmament beyond.

Autolycus.

Autolycus of Pitaneas wrote two books, one on the movable sphere, the other on the risings and settings of the stars. These are the most ancient of the astronomical works of the Greeks which have come down to our times.

Pytheas.

Pytheas of Marseilles, about the time of Alexander the Great, determined the length of the solstitial shadows in various countries by means of the gnomon. He found the shadows equal at Marseilles and Byzantium—a circumstance which does not give a favourable idea of the accuracy of his observations, inasmuch as the difference of the latitudes of the two places amounts to $2\frac{1}{4}$ degrees. The observation is, however, interesting, as it is the most ancient of the kind which has been preserved after that of Tcheou-Kong, and as it confirms the successive diminution of the obliquity of the ecliptic. Pytheas undertook several voyages for the purpose of obtaining geographical and astronomical information, and advanced northwards as far as Iceland. His relations have been treated as fabulous by Strabo and Polybius, but the accuracy of the greater number of them has been confirmed by modern observation and experience. He was the first who distinguished the climates by the different lengths of the days and nights.

Astronomy in the School of Alexandria.

In the history of the various sects which have hitherto come under our review, we meet only with some useful remarks, with numerous hypotheses and conjectures, but with scarcely any appearance of regular and connected science. Up to this date the astronomical knowledge of the Greeks was confined to a few facts, the discovery of which implies no theory, and scarcely the aid even of the simplest instruments. The order and arrangement of the planets, the causes of eclipses, the identity of the morning and evening stars, the approximate length of the year, that of the lunar month, the obliquity of the ecliptic, and the cycles of Meton and Calippus, were almost the sole results of their astronomical speculations. In the Alexandrian school we meet for the first time with regular and systematic observations. We there find angular distances measured with appropriate instruments, and calculations made according to the rules of trigonometry.

After the premature death of Alexander, his principal generals shared among themselves his magnificent conquests, and Egypt fell to the lot of Ptolemy Soter. This prince was distinguished by an ardent love of science, and a desire to promote every species of liberal knowledge. He accordingly invited to his court, which he had established at Alexandria, the most eminent philosophers of Greece, and fixed them there by his liberality and munificent protection. His son, Ptolemy Philadelphus, who inherited his throne, also inherited his genius and love of science and learning. A superb edifice, styled the *Museum*, was assigned to the use of the men of science whom he had attracted to his capital, to which he also added an observatory, and the famous library, which had been collected with great care and at a vast expense by Demetrius Phalerius. The prince took great delight in the Museum; he visited it frequently, entered into familiar conversation with its inmates on the subject of their various pursuits, and by his own example stimulated their

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Aristillus and Timocharis, 300 B. C. The first astronomers of the Alexandrian school were Aristillus and Timocharis, who flourished under the first Ptolemy, about 300 years before Christ. The chief object of their labours was the determination of the relative positions of the principal stars of the zodiac, instead of merely announcing their risings and settings, as had been the practice of the orientals and the ancient Greeks. The observations of these two astronomers conducted Hipparchus to the important discovery of the precession of the equinoxes, and served as the basis of the theory which Ptolemy, some centuries afterwards, gave of that phenomenon.

Aristarchus, B. C. 281. Aristarchus of Samos, the next in order of the Alexandrian astronomers, composed a treatise on the *Magnitudes* and *Distances* of the sun and moon, which has been preserved to our times. In this treatise he describes an ingenious method which he employed to obtain the relative distances of the two luminaries. At the instant when the moon is dichotomized, that is, when the exact half of her disk appears to a spectator on the earth to be illuminated by the sun's light, the visual ray passing from the centre of the moon to the eye of the observer is perpendicular to the line which joins the centre of the moon and sun. At that instant, therefore, he measured the angular distance of the two bodies, and finding it to be 87 degrees, he concluded, by the resolution of a right-angled triangle, that the distance of the sun is between eighteen and nineteen times greater than that of the moon. This method is perfectly correct in theory, but it is difficult to be assured of the exact instant of the moon's dichotomy, and in an angle of such magnitude a very small error greatly affects the result. The error of Aristarchus is very considerable, the true angle being about 87° 50′. The estimated distance of the sun is by consequence far too small; yet the determination, faulty as it was, contributed to expand greatly the existing notions relative to the boundaries of the universe, for the Pythagoreans had taught that the sun is only three, or at most three and a half times more distant than the moon. Another delicate observation made by Aristarchus was that of the magnitude of the sun's diameter, which, as we learn from Archimedes, he determined to be the 720th part of the circumference of the circle which the sun describes in his diurnal revolution. This estimate is not very far from the truth, and the observation is by no means an easy one. He embraced the doctrine of Pythagoras respecting the earth's motion, and appears to have entertained juster notions than any of the astronomers who preceded him, on the magnitude and extent of the universe. The treatise on the *Magnitudes* and *Distances* is published in the third volume of the works of Dr Wallis, with a Latin translation by Commandine, and some notes.

Eratosthenes, born 276 B. C. Eratosthenes, the successor of Aristarchus, was a native of Cyrene, and invited to Alexandria by Ptolemy Evergetes, who appointed him keeper of the royal library. He is supposed to have been the inventor of armillary spheres, a species of instrument extensively used by the ancient astronomers. By means of an instrument of this kind he observed the distance between the tropics to be to the whole circumference of a great circle as 11 to 83; a ratio equivalent to 47° 42′ 39″, half of which gives 23° 51′ 19·5″ for the obliquity of the ecliptic. This is a very important observation, and confirms the gradual diminution of the obliquity as indicated by theory. Eratosthenes is celebrated for being the first who attempted, on correct principles, to determine the magnitude of the earth. Having remarked, by some means with which we are unacquainted, that Syene, the most southern of the cities of ancient Egypt, is situated nearly on the same meridian with Alexandria, he conceived the idea of determining the amplitude of the celestial arch intercepted between the zeniths of the two places, and of measuring at the same time their distance on the ground; operations which would afford data for the determination of the whole length of the terrestrial meridian. Syene was known to be situated exactly under the tropic; for at the summer solstice the gnomon had no shadow, and the sun's rays illumined the bottom of a deep well in that city. On the day of the solstice he found the meridional distance of the sun from the zenith of Alexandria to be 7° 12′, or a fiftieth part of the circumference. It had also been ascertained by the *bematists* or surveyors of Alexander and the Ptolemies, that the itinerary distance between Alexandria and Syene was 5000 stadia; therefore $5000 \times 50 = 250{,}000$ stadia form the circumference of a great circle of the earth, or the length of the terrestrial meridian. Unfortunately, on account of the uncertainty respecting the length of the stadium here employed, we possess no means of estimating the degree of approximation afforded by this rude though ingenious attempt; but the idea does immortal honour to Eratosthenes, and the moderns have added nothing to his method: their better success is owing solely to the progress of the arts and the perfection of astronomical instruments.

About this time the science of astronomy was enriched by the discoveries of some of the distinguished geometricians whose labours have so greatly extended the glory of the Alexandrian school. Euclid, the celebrated author of the *Elements*, lived in the reign of the first Ptolemy. Euclid. He composed a book on the sphere, which probably served as a model for future works of the same kind, and was the first who treated in a geometrical manner of the phenomena of the different inclinations of the sphere. Conon of Samos, the friend of Archimedes, collected the records of eclipses, which had been observed by the ancient Egyptians; and Callimachus ascribes to him the constellation of Berenice's hair. Conon. Archimedes, whose profound genius and deep knowledge of geometry and mechanics entitle him to the appellation of the *Newton* of the ancients, also claims a high rank among the cultivators of astronomy. Archimedes. His celebrated planetarium, which represented the motions of the sun, moon, planets, and starry sphere, has been a frequent theme of the admiration and praises of the poets:

> *Jura poli, rerumque fidem, legesque deorum,*
> *Ecce Syracusius transtulit arte senex.*

Apollonius of Perga solved the important problem of the stations and retrogradations of the planets by means of epicyles and deferents; and he is entitled to the glory of having formed the alliance between the two sciences of geometry and astronomy, which has been productive of the greatest advantages to both. Apollonius.

Astronomy, which had as yet only consisted of a knowledge of isolated facts, acquired a systematic form, and almost a new existence, from the genius and assiduity of Hipparchus, one of the most astonishing men of antiquity, and perhaps the greatest of all in the sciences which are not purely speculative. Hipparchus, B. C. 140. This illustrious founder of astronomical science was born at Nice in Bythinia, and ob-

served at Rhodes. Flamsteed and Cassini, probably misled by some ambiguous expressions of Ptolemy, have related that his observations were made at Alexandria; and this opinion seems generally to have been adopted by historians. The question has been examined carefully, and at considerable length, by Delambre (*Astronomie Ancienne*), who comes to the conclusion that there is no reason whatever to infer that Hipparchus ever saw Alexandria. Ptolemy, in reporting the observations of Hipparchus, supposed Rhodes and Alexandria to be situated on the same meridian, and consequently does not find it necessary to mention the place at which the observations were made.

Hipparchus commenced his brilliant career by verifying the determination of the obliquity of the ecliptic made by Eratosthenes. He next directed his attention to the length of the tropical year. By comparing an observation of his own, of the summer solstice, with a similar one made by Aristarchus 140 years before, he found that the anciently received value of $365\frac{1}{4}$ days was too great by seven minutes. This leaves the tropical year a value still too great; but it is probable that the error arose from the inaccuracy of the observation of Aristarchus: for the observations of Hipparchus, compared with those of the moderns, make the length of the tropical year amount to 365 days, 5 hours, and 49 minutes, which is only 12 seconds greater than the truth. By a careful observation of the solstices and equinoxes, he discovered that the year is not divided by these points into four equal parts, the sun occupying $94\frac{1}{2}$ days in passing from the vernal equinox to the summer solstice, and only $92\frac{1}{2}$ from the same solstice to the equinox of autumn. The sun, consequently, remained 187 days in that part of the ecliptic which lies between the equator and the north pole, and therefore only about 178 in the other part. This observation led Hipparchus to the great discovery of the eccentricity of the solar orbit. He accounted for the apparent inequality of the sun's motion, by supposing that the earth is not placed exactly at the centre of the circular orbit of the sun, and that consequently his distance from the earth is subject to variation. When the sun is at his greatest distance, he appears to move more slowly; and when he approaches nearer, his motion becomes more rapid. The distance of the earth from the centre of the orbit is called the *eccentricity:* it produces an equation between the real and apparent motions, which is called the *equation of the centre.* He determined the magnitude of this equation in terms of the radius of the ecliptic, and fixed the position of the line of the apsides, or that which joins the two opposite points of the orbit which are at the greatest and least distance from the earth. With these data he formed the first tables of the sun which are mentioned in the history of astronomy. The discovery of the eccentricity also led Hipparchus to that of the inequality of the lengths of the solar days at different seasons of the year. In the interval which elapses between the sun's passage over the meridian and his return to it the following day, the sun advances by his own proper motion towards the east nearly a degree. But the rate of this motion is unequal, varying between 57 and 61 minutes of a degree; and the accumulation of the inequalities forms what is called the equation of time, that is, the difference between the true time, as shown by the sun, and the mean time, shown by a well-regulated clock, the motions of which are equal and uniform.

The attention of Hipparchus was next directed to the motions of the moon; and on this subject his researches were attended with equal success. From the comparison of a great number of the most circumstantial and accurate observations of eclipses recorded by the Chaldeans, he was enabled to determine the period of the moon's revolution relatively to the stars, to the sun, to her nodes, and to her apogee. These determinations are among the most precious relics of ancient astronomy, inasmuch as they corroborate the results of theory in one of its finest deductions—the acceleration of the mean lunar motion—and thus furnish one of the most delicate tests of the truth of Newton's law of gravitation. It was, indeed, by a comparison of the observations of Hipparchus with those of the Arabian and modern astronomers, that Dr Halley was led to the discovery of that curious and important phenomenon. Hipparchus also determined the eccentricity of the lunar orbit, and its inclination to the plane of the ecliptic; and the values which he assigned to these elements, making allowance for the evection and the inequalities of the moon's motion in latitude, are to a few minutes the same as those which are now observed. He had also an idea of the second inequality of the moon's motion, namely, the evection, and made all the necessary preparations for a discovery which was reserved for Ptolemy. He likewise approximated to the parallax of the moon, which he attempted to deduce from that of the sun, by determining the length of the frustum cut off from the cone of the terrestrial shadow by the moon when she traverses it in her eclipses. From the parallax he concluded that the greatest and least distances of the moon are respectively equal to 78 and 67 semi-diameters of the earth, and that the distance of the sun is equal to 1300 of the same semi-diameters. The first of these determinations exceeds the truth; the second falls greatly short of it, the distance of the sun being nearly equal to 24,000 terrestrial semi-diameters. It may, however, be remarked that Ptolemy, who undertook to correct Hipparchus with regard to the parallax, deviated still farther from the truth.

The apparition of a new star in the time of Hipparchus induced him to undertake the formation of a catalogue of all the stars visible above his horizon, to fix their relative positions, and mark their configurations, in order that posterity might have the means of observing any changes which might in future take place in the state of the heavens. This arduous undertaking was rewarded by the important discovery of the precession of the equinoxes. one of the fundamental elements of astronomy. By comparing his own observations with those of Aristillus and Timocharis, he found that the first point of Aries, which, in the time of these astronomers, or 150 years before, corresponded with the vernal equinox, had advanced two degrees, according to the order of the signs, or at the rate of 48 seconds a year. This determination is not very far from the truth; for, according to modern observations, the rate of the precession is about 50·1 seconds annually. His catalogue contained 1080 stars: it is generally, but erroneously, stated to have contained only 1022, after that of Ptolemy, in which the nebulous and some obscure stars are omitted. He also commenced a series of observations to furnish his successors with the means of forming a theory of the planets. Hipparchus likewise invented the planisphere, or method of representing the starry firmament on a plane surface, which afforded the means of solving the problems of spherical trigonometry in a manner often more exact and more commodious than the globe itself. He was the first who demonstrated the methods of calculating triangles, whether rectilineal or spherical; and he constructed a table of chords, from which he drew nearly the same advantages as we derive at present from the tables of sines. Geography is also indebted to him for the happy idea of fixing the position of places on

History. the earth by means of their latitudes and longitudes; and he was the first who determined the longitude by the eclipses of the moon.

These various labours and brilliant discoveries give a high idea of the industry and genius of Hipparchus. His writings have unfortunately all perished, excepting a commentary on the poem of Aratus; but the principal elements of his theories, together with a few observations, have been preserved in the Almagest of Ptolemy.

After the death of Hipparchus, nearly three centuries elapsed before any successor arose worthy of the name. During this long period astronomy gained no essential advancement. Some rude observations, scarcely superior to those of the Chaldeans, and a few meagre treatises, are the only monuments which exist to testify that science had not fallen into utter oblivion in an age so fertile of poets and orators. Geminus and Cleomedes wrote treatises, which have been preserved to our times; Agrippa and Menelaus are said to have observed; the Roman calendar was reformed by Julius Cæsar and the Egyptian astronomer Sosigenes; and Posidonius measured a degree, and remarked that the laws of the tides depend on the motions of the sun and moon.

Ptolemy, A. D. 130. Ptolemy was born at Ptolemais in Egypt, and flourished at Alexandria about the 130th year of our era, under the reigns of Adrian and Antoninus. This illustrious ornament of the Alexandrian school is entitled by his own discoveries to the high rank among astronomers which has universally been assigned to him; but the most signal service which he conferred on science was the collection and arrangement of the ancient observations. Out of these materials he formed the Μεγαλη Συνταξις, or *Great Composition*, a collection which exhibits a complete view of the state of astronomy in the time of Ptolemy, and which contains the germ of most of the methods in use at the present day.

The hypothesis which Ptolemy adopted for the purpose of explaining the apparent motions, was that which had been followed by Hipparchus. We have already seen that the genius of Pythagoras, soaring above the illusions of sense, had conceived the sun to be situated at the centre of the universe, and the earth to circulate, like the other planets, about the sun; and that the same opinion was entertained and supported by Aristarchus and a few other astronomers. It would seem, however, that this philosophical idea never gained much ground in antiquity, even among the learned. The vulgar prejudice respecting the immobility of the earth continued to prevail; and it had become an inveterate axiom, that all the celestial motions must be circular and uniform. Ptolemy himself, who felt in its full force the difficulty of reconciling the appearances with the notion of a uniform circular motion, adopted the common opinion without scruple as a primordial law of the universe; for, says he, this perfection belongs to the essence of celestial things, which neither admit of disorder nor irregularity. To save this chimera—the uniform circular motion—Apollonius imagined the ingenious apparatus of epicycles and deferents; and Hipparchus advanced a step farther, by placing the centre of the sun's circle at a small distance from the earth. Ptolemy adopted both hypotheses, and supposed the planet to describe an epicycle by a uniform revolution in a circle, the centre of which was carried forward uniformly in an eccentric round the earth. By means of these suppositions, and by assigning proper relations between the radii of the epicycle and deferent circle, and also between the velocity of the planet and the centre of its epicycle, he was enabled to represent with tolerable accuracy the apparent motions of the planets, and particularly the phenomena of the stations and retrogradations, which formed the principal object of the researches of the ancient astronomers. The notions of Apollonius and Hipparchus were thus reduced to a systematic form, and the proportions of the eccentrics and epicycles of all the planets assigned, by Ptolemy; on which account the system has been generally ascribed to him, and obtained the name of the *Ptolemaic System* of the universe. As a first attempt to bring the celestial motions within the grasp of geometry, it does infinite honour to the genius of its inventors. It is, however, totally irreconcilable with the precision of modern observations; for it is impossible to represent on this hypothesis the variations of the distances of the planets at the same time with their apparent motions. But this difficulty could scarcely be felt by Ptolemy, inasmuch as it was impossible, before the invention of the telescope and micrometer, to form any accurate estimate of the variations of the apparent diameter of a planet, and consequently of its distance. It must be admitted, however, that the Ptolemaic hypothesis might be sufficient for the wants of practical astronomy, that is, for calculating the places of the planets and forming tables of their motions, were it not for its extreme complication. The discovery of every new irregularity in the planetary motions exacts the addition of a new epicycle; and such was the confusion resulting from this circumstance, that Alphonso X., despairing of being able to comprehend the complicated machinery, was tempted to exclaim, that if the Deity had called him to his counsels at the creation of the world, he could have given good advice. Yet, notwithstanding all its defects, the system of Ptolemy gained a complete ascendency over the minds of mankind, and, so difficult is it to leave the beaten path, continued to be implicitly followed by every astronomer during fourteen centuries, having been only finally exploded by Kepler's discovery of the elliptic orbit of Mars.

The most important discovery which astronomy owes to Ptolemy is that of the *Evection* of the moon. Hipparchus had discovered the first lunar inequality, or the equation of the centre, which serves to correct the mean motion at the syzygies, and had also remarked the necessity of another correction for the quadratures. He even undertook a set of observations, with a view to ascertain its amount and its law; but death put a stop to his labours before he had brought them to a successful issue. Ptolemy completed the investigation, and discovered that the eccentricity of the lunar orbit is itself subject to an annual variation, depending on the motion of the line of the apsides. The variation of the position of the apsides produces an inequality of the moon's motion in her quarters, which has been technically denominated the evection. The equation given by Ptolemy, though of course empirical, is remarkably exact.

Ptolemy employed a very simple process for determining the moon's parallax, which was probably suggested to him by the situation of Alexandria, where he observed. He determined the latitude of a place a little to the south of that city, over the zenith of which the moon was observed to pass when her northern declination was the greatest possible. But when the moon is in the zenith, or in the same straight line with the observer and the centre of the earth, she has no parallax; consequently the obliquity of the ecliptic and the latitude of the station being known, the moon's greatest northern latitude was also determined. The next step was to observe the moon's meridian altitude fifteen days after the first observation, when her southern latitude was necessarily the greatest possible. This observation gave the *apparent* altitude of the moon, but her greatest northern and southern decli-

History. nations being supposed equal, her *true* altitude, as seen from the centre of the earth, was easily computed from the previous observation, and the difference between the true and apparent altitudes gave the amount of the parallax.

The observations of Hipparchus relative to the motion of the stars in longitude, or the regression of the equinoctial points, were confirmed by Ptolemy, although he mistook its amount, and diminished a quantity which Hipparchus had already estimated too low. According to Hipparchus, the regression is at the rate of two degrees in 150 years. Ptolemy reduced it to one degree in 90 years. This disagreement would seem to indicate an error of more than a degree in the observations, which can with difficulty be admitted, considering the accordance which subsists among the different observations cited by Ptolemy in support of his own determination. For this and some other reasons Ptolemy has been accused of altering the observations of Hipparchus, and accommodating them to his own theory; but there does not appear to be any just ground for the imputation. The error with regard to the regression probably arose from the circumstance, that Hipparchus had assigned too great a value to the length of the year, whence the motion of the sun with regard to the equinoxes would be made too slow, and the longitudes employed by Ptolemy consequently diminished.

Ptolemy has been called the *Prince* of astronomers,—a title which may perhaps be justified by the universal and long-continued prevalence of his system, but to which he has no claim from the number or value of his own observations. After a laborious and minute examination of the Almagest, Delambre doubts whether any thing, saving the author's declarations, is contained in that great work, from which it can be decisively inferred that Ptolemy ever observed at all. He indeed frequently makes mention of observations made by himself; but his solar tables, rate of the precession, eclipses, determination of the moon's motion and parallax, and, above all, his catalogue of stars, render it impossible to doubt that the greater part of the results which he has given as observations are merely computed from the tables of Hipparchus. It is therefore difficult to allow to Ptolemy that good faith and "astronomical probity which forms one of the most indispensable qualities of an observer." He never in any instance cites a single observation more than is just necessary for the object he has immediately in view, and consequently, by precluding all comparison of one observation with another, has deprived us of the means even of guessing at the probable amount of the errors of his solar, lunar, and planetary tables. If an astronomer, as Delambre justly remarks, were to adopt the same course at the present day, he would be certain of forfeiting all claim to confidence; but Ptolemy stood alone; he had neither judges nor rivals; he claimed admiration, and received it; and now no one condescends to calculate the few observations he has left us. (Delambre, *Astronomie Ancienne*, tom. i. Discours Préliminaire.) His catalogue contains only 1029 stars, and is therefore less extensive than that of Hipparchus, but it is exceedingly valuable on account of its details.

The name *Almagest* (Μεγίστη, with the Arabic prefix) was bestowed on the *Syntax* by the Arabians, into whose language it was translated in the ninth century. The first Latin translation was from the Arabic, and published at Venice in 1515. It abounds in Arabic words and idioms, and is very inaccurate and barbarous. The second Latin translation was made from the original Greek by George of Trebizond, and is greatly superior to the first. It was published at Basle in 1541, and in 1551. The Greek text was published at the same time in 1538. History

Ptolemy was the author of numerous other works connected with astronomy, of which his *Geography*, in eight books, is the best known. It contains a list of all the places of which the latitudes and longitudes had at that time been determined. His treatise on *Optics* was supposed to be lost, till an imperfect Latin translation, from an Arabic version, was lately discovered in the king's library at Paris. The last book of this work contains a theory of astronomical refraction, more complete than any which existed before that of Cassini. It would seem that Ptolemy had not discovered the refraction at the time he composed the Almagest, no mention being made of the subject in that work. The explanation which he gives of the phenomenon is natural and satisfactory, indeed entirely conformable with that which is now universally adopted. The idea and explanation remained buried in the *Optics* till reproduced by Alhazen; but neither Ptolemy nor Alhazen attempted to estimate the amount of the refraction. His *Planisphere* and *Analemma*, in which he treats of the stereographic and orthographic projections of the sphere, show a perfect acquaintance with spherical trigonometry. In the last-mentioned work he makes use of the sines, and his constructions comprehend three of the four general theorems in modern use. Divers treatises also on music, dialling, chronology, and mechanics, attest the universality of Ptolemy's genius, and his unremitting application to the pursuits of science. Like Archimedes, he had a desire to transmit to posterity the history of his labours by a public monument. In the temple of Serapis, at Canopus, he is said to have consecrated a marble pillar, with an inscription containing the principal elements of his astronomy, such as the length of the year, the eccentricity of the solar and lunar orbits, the dimensions and forms of the epicycles of the planets, &c.

Decline of astronomy.

On the death of Ptolemy astronomy ceased to be cultivated among the Greeks. The Alexandrian school subsisted indeed for some centuries after; but genuine science had fled, and its place been usurped by the vain wranglings of theologians and grammarians. During the long period of six or seven centuries, the labours of those who assumed the name of astronomers were confined to needless or trifling commentaries on the works of Hipparchus and Ptolemy, and were productive of no observations, or even remarks, having a tendency to enlarge the boundaries of the science. The genius of the Roman dominion was unfavourable to the development or exercise of the higher faculties of the human intellect; and the natural sciences, with the liberal arts, faded away under the withering influence of military despotism.

From the brief account which has now been given, it will be easily inferred that the Greeks cultivated astronomy rather as a speculative than a practical science. None of their numerous sects ever evinced any taste for observation or experiment; and hence, while geometry made great and rapid advances in their hands, physics and experimental philosophy were entirely neglected. The prevailing passion for speculation pervaded even their astronomy. They explained the doctrine of the sphere, and the apparent motions of the planets; and framed ingenious theories to account for such phenomena as came immediately under the cognizance of their senses; but if we except the observations of Hipparchus and Ptolemy, and perhaps two solstitial distances of the sun from the zenith, observed by Eratosthenes, we remark among them no observations made with instruments capable of measuring angular distances. Before Hipparchus, no mention is made of the astrolabe; and the recorded determinations do not

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give us a very favourable idea of the accuracy of that instrument. On casting our eyes over the catalogue of Ptolemy, we scarcely ever meet with a fraction of a degree smaller than one-twelfth, that is to say, less than five minutes; whence we may infer that the astrolabe only measured twelfth parts of a degree. Occasionally, indeed, the fractions one-fourth and three-fourths occur; but these were most probably inserted by estimation. The Greeks of Alexandria committed an error of no less than 15′ with regard to the altitude of the pole, one of the most essential elements to an observer; and it does not appear that they were ever able to determine the time to within a quarter of an hour. Yet notwithstanding these circumstances, which indicate that the art of observation was still in its infancy, the science of astronomy is vastly indebted to the labours and speculations of the Greeks. The complicated but ingenious hypotheses of Ptolemy prepared the way for the elliptic orbits and laws of Kepler, which, in their turn, conducted Newton to the great discovery of the law of gravitation.

Astronomy of the Arabians.

While the nations of western Europe were involved in the thickest shades of ignorance and barbarism, the torch of science was rekindled, and blazed forth with extraordinary splendour, among the Saracens. The burst of fanaticism which enabled the followers of Mahomet to carry their religion and their arms over the fairest portion of the ancient world subsided, in a great measure, after a century and a half of uninterrupted conquest, and was succeeded by a period of repose, during which they cultivated the arts of peace and civilisation with the same ardour which had characterized their achievements in arms. Under the enlightened and munificent protection of the caliphs, Bagdat became what Alexandria had been under the Ptolemies, the centre of politeness and knowledge.

The accounts which we possess of the Saracen literature are imperfect and scanty; but the first of the caliphs who appears to have encouraged the study of astronomy was Abougiafar, surnamed Almansor, or the Victorious, who reigned in the eighth century. His grandson Almamon, the seventh of the Abassides, and second son of the famous Haroun Al Raschid, who reigned at Bagdat from 813 to 833, is celebrated for the protection which he gave to learning, and the zeal with which he laboured to propagate the sciences of the Greeks among his subjects. In granting peace to the emperor Michael III., he stipulated for liberty to collect in Greece all the writings of the philosophers. These he transported into his own country, and caused to be translated into Arabic. Finding it mentioned in the geography of Ptolemy that a degree of the earth was equivalent to 500 stadia, he resolved to have this fact verified by a new measurement; and in obedience to the commands of the caliph, a company of mathematicians assembled in the spacious plain of Sinaar, where, having observed the altitude of the pole, they separated themselves into two parties, and proceeded in opposite directions along the meridian, measuring the distance they passed over till the altitude of the pole varied one degree. Being unacquainted with the nature of the instruments made use of in these geodetic operations, we cannot estimate the probable accuracy of the result; but as it agreed perfectly with the statement of Ptolemy, we have a right to infer that the measurement was executed in a very inadequate manner, and that the mathematicians of the caliph adopted the ancient determination from want of confidence in their own.

The *Syntax* of Ptolemy was translated into Arabic under the reign of Almamon, by Isaac Ben Honain. The translation was afterwards revised by Thabet or Thebith Ben Korah, and it was about this time that it received the appellation of Almagest. Astronomical observations, which, as we have had occasion to remark, had been greatly neglected by the successors of Hipparchus, formed a principal object of the attention of the Arabians. By the orders of Almamon, the obliquity of the ecliptic was observed, and found to be 23° 33′. According to the modern tables, the obliquity at that time was 23° 36′ 34″, so that the error was less than that of Hipparchus and Ptolemy, in their determination of the same element. This observation supposes instruments of some accuracy. Among the astronomers whom Almamon drew to his court, we find the names of Habash of Bagdat, who composed three books of astronomical tables; Ahmed, or Mohammed Ben Cothair, better known by the name of Alfragan, or Alfranius, who, from his great expertness in computing, was styled the *calculator*. He composed an elementary treatise on astronomy, which was only an abridged extract of the works of Ptolemy; and likewise wrote on sun-dials, and gave a description of the astrolabe. The Jew Meshala, whose treatise on the elements was published at Nuremberg in 1549, also lived in the time of Almansor or Almamon.

Albategnius.

The most celebrated of the Arabian astronomers was Albategnius, or Muhammed Ben Geber Albatani, so called from Batan, a city of Mesopotamia, where he was born. He was a prince of Syria, and resided at Aracte or Racha, in Mesopotamia; but many of his observations were made at Antioch. Having studied the *Syntax* of Ptolemy, and made himself acquainted with the methods practised by the Greek astronomers, he began to observe, and soon found that the places assigned to many of the stars in Ptolemy's tables were considerably different from their actual situations, in consequence of the error which that great astronomer had committed with regard to the precession of the equinoxes. Albategnius measured the rate of the precession with greater accuracy than had been done by Ptolemy; and he had still better success in his attempt to determine the eccentricity of the solar orbit, his value of which differs extremely little from that which results from modern observations. In assigning the length of the year, however, he fell into an error of more than two minutes; but this proceeded, as has been shown by Dr Halley, from too great confidence in the observations of Ptolemy. Albategnius also remarked that the place of the sun's apogee is not immovable, as former astronomers had supposed, but that it advances at a slow rate, according to the order of the signs,—a discovery which has been confirmed by the theory of gravitation. A new set of astronomical tables, more accurate than those of Ptolemy, likewise resulted from the indefatigable labours of Albategnius; and his observations, important in themselves, are doubly interesting on account that they form a link of connection between those of the astronomers of Alexandria and of modern Europe. The works of Albategnius were published in 1537, under the title of *De Scientia Stellarum.*

Thebith Ben Korah.

Thebith Ben Korah, another Arabian, acquired celebrity by proposing an explanation of the motions of the stars, which, under the name of the "System of Trepidation," was eagerly received by the astronomers of the middle ages, and disfigured the tables of Alphonso, and even those of Copernicus. He ascribed to the *eighth* sphere, or that of the fixed stars, two motions; one the diurnal motion, the other that of trepidation, performed in small circles round the first points of Aries and Libra, and of

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which the radii were 4° 18′ 33″. He therefore supposed two ecliptics, one fixed in the ninth sphere, the other movable in the eighth. According to this construction, the motion of the stars is sometimes direct and sometimes retrograde.

The Arabians have been said to be not only the cultivators but the apostles of the sciences, on account of the activity with which they propagated them among all the nations subjected to their dominion. The Fatimite caliphs, who reigned in Egypt during two centuries, rivalled their predecessors the Ptolemies in the encouragement which they gave to astronomy. Under the caliph Hakem, who reigned from 996 to 1021 of our era, Ebn Jounis acquired a splendid reputation. He constructed a set of tables, and composed a sort of celestial history, in which he has recorded numerous observations of his own and of other astronomers belonging to the same country. This work, imperfectly known through some extracts, long excited the curiosity of astronomers, as it was supposed to contain observations tending to establish the acceleration of the mean motion of the moon. A manuscript copy of it, belonging to the university of Leyden, was, in 1804, transmitted to the French Institute, and translated by Professor Caussin. It contains 28 observations of eclipses from the year 829 to 1004; seven observations of the equinoxes; one of the summer solstice; one of the obliquity of the ecliptic made at Damascus, by which the value of that element is found to be 23° 35′; and likewise a portion of tables of the sun and moon, with some other matter illustrative of the state of astronomy among the Arabians. The observations which regard the acceleration of the mean lunar motion are two eclipses of the sun and one of the moon, observed by Ebn Jounis, near Cairo, in the years 977, 978, and 979, and they agree with theory in confirming the existence of that phenomenon.

Ebn Jounis.

The Saracen conquests in Spain were attended with the same happy results as in Egypt, and science flourished in that country while the rest of Europe was involved in the darkest shades of ignorance. Arzachel is supposed to be the author of the *Toledo Tables*, constructed about the year 1180, but which, on account of the established reputation of those of Albategnius, were never in great estimation. He made some changes in the dimensions which had been assigned by Hipparchus and Ptolemy to the solar orbit, and deserves the praise of having been an exact and attentive observer. Alhazen, who flourished in the same country about the same period, contributed to the progress of astronomy by a treatise on *Optics*, in which he clearly indicated the necessity of making an allowance for the celestial refraction in astronomical observations. His treatise contained a theory of reflection and refraction, an explanation of the cause of the twilight, and of the magnitude of the horizontal moon. Averroes, a physician of Cordova, made an abridgement of the Almagest in the twelfth century, and Almansor found the obliquity of the ecliptic to be 23° 33′ 30″, which proves that practical astronomy had now attained to a tolerable degree of exactness.

Arzachel.

Alhazen.

Averroes.

If we inquire what effect the labours of the Arabians and their disciples had on the progress of astronomy, we shall find that their services were confined entirely to the practical part. In point of theory they did absolutely nothing. They admitted all the hypotheses of Ptolemy without the slightest alteration, even with timid and superstitious respect, and did not advance a single step towards the discovery of the solar system. But with regard to instruments and methods of calculation, their improvements were numerous and important. They constructed instruments on a larger scale, and divided them with greater care; and, even from the time of Almamon, we remark among them new and more exact determinations of the obliquity of the ecliptic, of the positions of some stars, of the precession, of the length of the year, and of the eccentricity of the sun's orbit. To these fundamental points they added numerous observations of eclipses and conjunctions; they industriously sought out and corrected the errors of Ptolemy's tables; they perceived the necessity of marking the instant of each phenomenon with greater care; and their determinations of the commencement and end of eclipses are in general accompanied with the altitude of a star, which afforded them the means of calculating the hour, angle, and the true time. In cases where less precision was wanted, they made use of their clepsydræ and solar dials, to the construction of which they paid particular attention. Trigonometry derived signal advantages from their constant care to facilitate the calculations of spherical astronomy. Albategnius substituted the sines for the chords,—a most important improvement, the idea of which was probably suggested to him by the Analemma of Ptolemy. By this happy substitution the solution of all rectangular spherical triangles was reduced to four general formulæ, of which the Greeks had the equivalent in a much less commodious form. The same astronomer also appears to have invented a very remarkable rule for the oblique-angled triangles, perfectly identical with one of the four general formulæ now in use. Ebn Jounis, and his contemporary Aboul Wefa, were acquainted with the tangents and secants, and employed them very dexterously in reducing complicated binomial expressions to a single and simpler term. They also employed subsidiary arcs and other artifices in the calculus of the sines, in order to facilitate the labour of computation. These substitutions are now common; but they remained long unknown in Europe; and 700 years after they were employed by the Arabians, we first meet with some examples of their use in the writings of Thomas Simpson.

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The zeal of the Arabians for astronomical observations was communicated by them to the Persians and Tartars. About the year 1072, Omar Cheyam determined the length of the tropical year, and introduced the calendar which has ever since been used in Persia. Holegu-Ilecou-Khan, who conquered that country about the year 1264, caused an observatory to be built at Maragha, near Tauris, where he assembled the most celebrated astronomers who could be found within his dominions, and employed them in forming new astronomical tables. This work was directed by the famous Nassireddin, and brought to a conclusion in the year 1269. With the exception of some trifling corrections of the mean motions, the whole of these tables are copied from Ptolemy.

Holegu-Ilecou-Khan, died 1269.

Ulugh Beigh, a Tartar prince, and grandson of the great Tamerlane, not only encouraged the study of astronomy, but was himself a diligent and successful observer. At Samarcand, the capital of his dominions, he established an academy of astronomers, and caused the most magnificent instruments to be constructed for their use. By means of a gnomon 180 feet in height, he determined the obliquity of the ecliptic to be 23° 30′ 20″, the precession of the equinoxes at 1° in 70 years, and obtained elements for the construction of tables which have been found to be scarcely inferior in accuracy to those of Tycho Brahé. The ancient astronomy had produced only one catalogue of the fixed stars, that of Hipparchus. Ulugh Beigh has the honour of having formed a second, after an interval of sixteen centuries. This learned and munificent prince, whose virtue and talents deserved the esteem of mankind, was assassinated by his own son in the 58th year of his age.

Ulugh Beigh, died 1449

Revival of Astronomy in Europe.

After the death of Ulugh Beigh, astronomy received no farther accessions in the east. But the seeds of knowledge had now begun to take root in a more propitious soil, and Europe, destined to carry the development of the human energies to its fullest extent, began to awake from the lethargy in which it had continued during so many ages. The first dawnings of returning day appeared in Spain. In spite of the horror inspired by the Moslem religion, the Christians began to perceive and acknowledge the superiority and utility of the science of the Moors; and the schools of Cordova became the resort of all those whom curiosity, or love of knowledge, induced to seek abroad for that information which could not be obtained in their own countries. Geber, afterwards Pope Silvester II., acquired the knowledge of arithmetic from that source; and John of Halifax, better known by the name of Sacrobosco, after having studied some time in Spain, made an abridgement of the Almagest, which was long famous under the title of a *Treatise of the Sphere*.

Frederick II.

The emperor Frederick II. is no less celebrated for his protection of the sciences, than for the continual struggles in which he was involved with the popes. He founded the university of Naples, and caused Latin translations to be made of the works of Aristotle and the Almagest of Ptolemy. About the same time astronomy was zealously encouraged and cultivated by Alphonso X., king of Castile. This monarch, whose liberal mind seems to have been far superior to the age in which he lived, formed a college or lyceum at Toledo, the capital of his dominions, whither he assembled the most eminent astronomers that could be found, whether Christians, Moors, or Jews, and engaged them in the task of correcting the errors of the ancient tables. From their united labours were produced the *Alphonsine Tables*, which obtained great celebrity, and were, in some respects, superior in accuracy to any which had preceded them. They are supposed to have been chiefly the work of the Rabbi Isaac Aben Sid, surnamed Hazan, inspector of the synagogue of Toledo. They are said to have cost the king 40,000 ducats,—a sum certainly far exceeding their real value, which is confined to the correction of some epochs, and a more accurate determination of the sun's motions and the length of the year. The same century gave birth to several other individuals distinguished by their attachment to the sciences. Campanus of Nivari translated Euclid, and left a treatise on the sphere. Vitello, a native of Poland, composed a treatise on optics, in ten books; and Albert, bishop of Ratisbon, whom his contemporaries styled the *great*, was the author of some works on arithmetic, geometry, astronomy, and mechanics. But the greatest luminary of that age was Roger Bacon, a Franciscan friar, whose numerous works contain many indications of a powerful and inventive genius. He made many important discoveries in optics; but his knowledge of natural philosophy and chemistry, uncommon in those days, had nearly proved fatal to him; for he was suspected of necromancy, and thrown into a dungeon, from which he did not escape till he had satisfied his superiors and the pope that he had never held unlawful intercourse with the devil. He composed a work on the utility of astrology, the places of the stars, and the aspects of the moon; and he had the merit of perceiving the necessity of reforming the calendar.

Alphonso X., died 1284.

Roger Bacon, born 1214, died 1294.

urbach, born 1423, died 1461.

The fourteenth century produced no astronomer from whose labours the science gained any accessions. George Purbach, or Beurbach, so named from a small town in Austria, where he was born in 1423, obtained great celebrity as a professor. He studied at Vienna, and after giving proofs of distinguished talents, he travelled into Italy, where he was favourably received by the cardinal of Cusa, who himself cultivated astronomy. On his return to Vienna he undertook a translation of the Almagest; and although ignorant both of Greek and Arabic, his perfect acquaintance with the subject enabled him to correct many errors which had been introduced through the carelessness or ignorance of former translators. He published a table of sines for every ten minutes to a radius of 6,000,000 parts, which was afterwards extended by his scholar Regiomontanus to every minute of the quadrant. The most celebrated of his works is his *Theoricæ Novæ Planetarum*, which was published in 1460. He constructed a celestial globe, on which was represented the motion of the stars in longitude from the time of Ptolemy to the year 1450. He also measured the obliquity of the ecliptic, and is considered as the inventor of decimal arithmetic. He died in 1461, having only reached his 38th year, with the reputation of being, at that time, the first astronomer in Europe.

Regiomontanus, born 1436, died 1475.

Purbach had the good fortune to form a disciple who executed many of the plans which had been interrupted by his premature death. This was the celebrated John Muller of Königsberg, better known by the name of Regiomontanus. Attracted in his youth to Vienna by the great reputation of Purbach, he continued to study there during ten years, and on the death of his master repaired to Rome for the purpose of acquiring the Greek language, and of making himself, through it, acquainted with the Almagest. At Rome he continued his observations, and translated into Latin the works of Ptolemy, the *Conics* of Apollonius, and some other treatises of ancient science. In 1471 he retired to Nuremberg, where, with the aid of Bernard Walther, a wealthy burgess, he founded an observatory, and furnished it with excellent instruments, principally of his own invention, by means of which he was enabled to detect many errors in the ancient tables. On the invitation of Pope Sixtus IV., who wished to reform the calendar, he again repaired to Rome; but after a few months' abode there he died suddenly, according to some accounts, of the plague, according to others, through the effects of poison administered to him by the sons of George of Trebizond, who adopted this execrable method of revenging the exposure which he had made of their father's errors in the translation of the Almagest. Regiomontanus was a learned and skilful man, but the great expectations which his early labours gave of future services to astronomy were disappointed by his untimely death. He paid great attention to trigonometrical calculation; and, although he did not reach the point which had been attained by the Arabians, he had the merit of introducing some useful theorems which till then were entirely unknown in Europe. His genius, however, did not enable him to rise above the prejudices of his age, for he was an astrologer as well as an astronomer, and is said to have most lamented the errors of the Alphonsine Tables on account of the uncertainty which they occasioned in the calculation of genitures or horoscopes.

Walther, born 143[illegible], died 150[illegible].

After the death of Regiomontanus, Walther continued to observe at Nuremberg during thirty years. His observations were collected by order of the senate of Nuremberg, and published by Schöner in 1544, a second time by Snellius, and, lastly, along with those of Tycho Brahé. In 1484 Walther began to make use of clocks, then a recent invention, to measure time in celestial observations. He was also the first who employed the planet Venus as a term of comparison for determining the longitudes of the stars.

Nuremberg had the honour of producing another astro-

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Werner, born 1468.

nomer of some celebrity. John Werner was the first who explained the method which was afterwards brought into general use by Maskelyne, of finding the longitude at sea, by observing the distance between a fixed star and the moon. He published some mathematical and geographical treatises, and made a number of observations to determine the obliquity of the ecliptic and the precession of the equinoxes.

Overthrow of the Ptolemaic system.

We are now come down to a period in the history of astronomy when the science was destined to undergo a total renovation, and the system which had been so laboriously established by Ptolemy, and blindly followed as an article of religious belief by Arabs, Persians, Tartars, and Europeans, during so many centuries, was about to be exploded for ever. In proportion as the observations became more numerous and accurate, the difficulty of representing them by the Ptolemaic system became greater; and astronomers were obliged to have recourse to the most violent and improbable suppositions in order to explain the phenomena, and, in the language of Ptolemy, *save* the appearances. We have mentioned that Pythagoras and his disciples entertained an idea very different from that which commonly prevailed, and supposed the sun to be the immovable centre of the celestial motions. It appears, however, from Aristotle, that this opinion was not founded on any analysis of the phenomena, but on certain metaphysical notions respecting the comparative dignity of the several elements. For example, fire, being a nobler substance than earth, ought to occupy the centre or place of honour. But such arguments could have little weight except in the schools, and accordingly were rejected by Ptolemy as too absurd to require a serious refutation. In order to give any probability to the Pythagorean doctrine, it was necessary to explain the succession of the seasons and the precession of the equinoxes on the hypothesis of the annual revolution of the earth about the sun; to show how the unequal motions of the planets in concentric orbits would give rise to the phenomena of the stations and retrogradations; to account, in short, for all the appearances, and point out their coherence and mutual connection. All this was effected by Copernicus, who had thereby the glory of first making known the true system of the universe, and of leading the way in that career of astronomical discovery in which the genius of the human race has gained its noblest trophies.

Copernicus, born 1472, died 1543.

Nicholas Copernicus was born at Thorn, a city of Prussia, on the confines of Poland, according to Junctinus on the 19th of January 1472, and according to others on the 19th February 1473. From his earliest years he displayed a great fondness and aptitude for mathematical studies, and pursued them with corresponding success at the university of Cracow. Stimulated by the desire of acquiring a reputation equal to that of Regiomontanus, he set out for Italy at the age of 23 years, in order to study astronomy at Bologna under the celebrated Dominic Maria. He afterwards removed to Rome, where he employed himself in studying and teaching the mathematics, and where he made several astronomical observations about the year 1500. On his return to his native country he was made a canon of Ermeland by his uncle the bishop of Worms, and took up his residence at Frauenberg, a small Prussian town near the mouth of the Vistula, where he passed 36 years of his life in observing the heavens and meditating on the system of the world. In this retirement he composed his famous work entitled *Astronomia Restaurata, sive de Revolutionibus Orbium Cœlestium,* in which he explained the celestial motions in a manner as simple and connected as the system of Ptolemy was complicated and incoherent. The system which Copernicus adopted in this work is now so familiar to every one, that it is almost unnecessary to describe it. The heaven, composed of stars perfectly at rest, occupies the remotest bounds of space, then the orbit of Saturn, next Jupiter, Mars, the Earth accompanied by its moon, Venus, Mercury, and, lastly, the Sun immovable at the centre. By this arrangement the stations and retrogradations of the planets became simple mathematical corollaries, following from the differences of the radii of their orbits and their unequal motions. The diurnal rotation of the earth explained more simply and rationally the apparent daily revolution of the heavens; and the precession of the equinoxes was referred to a small variation in the inclination of the earth's axis to the plane of the ecliptic. But the simplicity of the system, and its consequent probability, were the only arguments which Copernicus was able to bring forward in proof of its reality. The motion of the earth can indeed never be made an object of sense; but after Richer's discovery of the diminution of gravity towards the equator, it was impossible to doubt longer of the existence of its rotatory motion; and when Roemer had measured the velocity of light, and Bradley observed the phenomena of the aberration, the evidences of its annual revolution were rendered equally convincing. Great, however, as were the merits of Copernicus, it must be acknowledged that he left his system in a very imperfect state. After the example of the ancients, he assumed as an axiom the uniform circular motion of the planets; and as the only motions which are observed are in a state of incessant variation, he was obliged, in order to save the inequalities, to suppose a different centre to each of his orbits. The sun was placed *within* the orbit of each of the planets, but not in the centre of any of them, consequently he had no other office to perform than to distribute light and heat; and, excluded from any influence on the system, he became as it were a stranger to all the motions. Yet notwithstanding these and other imperfections, the establishment of the doctrine of the earth's motion, with an evidence which dissipated the illusions of sense, was a great step towards the true knowledge of the planetary system; and when we consider the ignorance and prejudices of the age, and that Copernicus was moreover a priest, we cannot hesitate to admit his claim to a high rank among philosophers. But whether the actual services which he rendered to astronomy are commensurate with the great fame he has obtained, may admit of doubt. He revived an ancient opinion opposed to the prejudices and religious dogmas of his times, and fortified it with new and strong, though not absolutely convincing, proofs. It seldom happens, however, with regard to those sciences which ultimately appeal to experience, that general reasoning, even of the soundest kind, tends much to their real advancement; and there is little reason for thinking that astronomy would have been less perfect, or that any discoveries since made in it would have been retarded a single day, even if Copernicus had never lived. His great merit, like that of Lord Bacon, consists in the sound views which he took of nature, and in advancing so far before the general attainments of his age.

Fearing the opposition which was likely to arise from religious bigotry to opinions so much at variance with vulgar prejudice, Copernicus long delayed the publication of his great work; and it was only at the urgent request of his friends that he at last allowed it to be printed. He is said to have received the last sheet of it only on the day of his death. He was buried in the cathedral of Frauenberg, and his only epitaph consisted of some spheres cut out in relief on his tombstone.

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The ideas of Copernicus soon spread over Germany, where astronomy was at that time diligently cultivated; but they do not seem to have met with general favour before the commencement of the seventeenth century. The art of observing was, however, gradually receiving improvement; instruments were constructed on better principles, and more accurately divided; and the methods of computation were rendered much less laborious. Nonius, or Nunez, a Portuguese, invented the ingenious method of subdividing the small divisions of instruments which still retains his name; Reinhold extended the table of tangents of Regiomontanus to every minute of the quadrant, reformed the tables of Copernicus, and composed many works of practical utility; but of the immediate successors of Copernicus, no one deserves to be more honourably mentioned than William IV., landgrave of Hesse. This prince built a magnificent observatory on the top of his palace at Cassel, which he furnished with excellent instruments of copper, and is said to have calculated himself the positions of no less than 400 stars. He was aided in the labours of the observatory by some astronomers of great merit whom his liberality drew to his court; among others, by Rothman, and Justus Byrgius, a distinguished artist, to whom Kepler has ascribed some idea of the logarithms.

Nonius, born 1497, died 1577.

William IV., died 1592.

Tycho Brahe, born 1546, died 1601.

Tycho Brahe, one of the best and most indefatigable observers of whom practical astronomy can boast, was born at Knudstorp, in Scania, the 13th of December 1546. His family was one of the most ancient and noble in Denmark; and his father, probably thinking that illustrious birth superseded the necessity of education, refused his consent to have his son instructed in Latin. Through the kindness of a maternal uncle, however, he was rescued from the state of barbarous ignorance to which he had been doomed by his parent; and, after having received the requisite preliminary instruction, he was sent to the university of Leipsic to study jurisprudence and scholastic philosophy. The tastes of the future astronomer were first excited by an eclipse of the sun which happened in 1560. Struck with astonishment at the accuracy of the prediction, he conceived a vehement desire to become acquainted with the principles of so certain a science, and exerted his utmost ingenuity to elude the obstacles which were interposed by his parents and governor to prevent him from acquiring the elementary notions of mathematics and astronomy. By placing the hinge of a common compass near his eye, he contrived to guess at the distances of the planets from the stars, and by this means, according to his own account, detected several errors in the Ephemerides of Stadius. By his persevering efforts he at last obtained the consent of his family to study according to his own inclinations; and from that moment he divided his time between the observation of the heavens, and chemical experiments. He visited the different cities of Germany where he hoped to meet with astronomers and skilful mechanicians, and was received with flattering attention by the landgrave of Hesse-Cassel, with whom he contracted an intimate friendship. On his return to Denmark he obtained from Frederick II. a grant of the small island of Huen, in the strait of Sunda, together with a pension and some presents, by means of which, and an expenditure of 100,000 crowns of his own patrimony, he was enabled to build the castle of Uraniburg, and procure a magnificent collection of the largest and most accurate instruments which could then be constructed. In this celebrated retreat he passed twenty-five years, actively employed in making observations, and attracting by his discoveries the attention of the learned throughout Europe. On the death of his protector Frederick he fell under the displeasure of the government, and a storm of persecution was raised against him, from causes which he has not explained, by a minister named Walckendorp, who, on this account, has been devoted by Lalande to the infamy and execration of all ages. He was deprived of his pension, compelled to leave the castle of Uraniburg, and to banish himself from Denmark. He retired first to Wandesburg, near Hamburg; he afterwards sought an asylum in Bohemia, and ultimately settled at Prague under the protection of the emperor Rudolph II. Here he resumed his observations, assisted by the illustrious Kepler and Longomontanus. The causes of his exile are involved in mystery; but to whatever it was owing, it turned out fortunate for the progress of astronomy. Had he remained in his island, his observations would not probably have fallen into the hands of Kepler, and the discovery of the laws of the planetary motions might have been deferred to another age. He died at Prague on the 24th of October 1601.

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As an indefatigable and skilful observer, Tycho is justly considered as far superior to any astronomer who had preceded him since the revival of the science in Europe. His ample fortune gave him the means of procuring the best instruments which the age could produce; and by his ingenuity and persevering application, he was admirably qualified to employ them to the best advantage. He computed the first table of refractions, and if it extended only to 45°, the reason was, that the effects of refraction, at a higher altitude, were altogether insensible to his instruments. His solar tables were brought to so great a degree of exactness, that he affirms he could never detect an error in them exceeding a quarter of a minute; but there is reason to suspect some exaggeration in this statement, particularly as Cassini, a century after, with much better means, could scarcely answer for errors of a whole minute. He contributed greatly to the improvement of the lunar tables, and detected a considerable inequality in the moon's motion in longitude, to which he gave the name of the *Variation*, by which it has ever since been distinguished. He also discovered an equation in latitude similar to the evection which had been observed by Hipparchus, and fixed its amount with great accuracy. He remarked the fourth inequality of the moon in longitude, although he failed in his attempt to ascertain its amount, or assign its law. He represented the inequalities of the motions of the nodes, and in the inclination of the lunar orbit, by the motion of the pole of that orbit in a small circle round the pole of the ecliptic. He demonstrated that the region of the comets is far beyond the orbit of the moon, and determined the relative and absolute positions of 777 fixed stars with a scrupulous attention, which gave his catalogue an immense superiority over those of Hipparchus and Ulugh Beigh; and he left to his successors a regular series of observations on the planets, amassed for the purpose of establishing the truth of his own system, but of which Kepler made a better use by employing them to establish the system of Copernicus.

These are some of the important benefits which resulted to astronomy from the labours of Tycho. As a philosopher he ranks low. Alchemy and judicial astrology, in the reveries of which he was a firm believer, engrossed as much of his attention as astronomy. Yet his errors, or rather weaknesses, ought to be viewed with indulgence. He was seated, to use the simile of Bailly, on the confines of two ages; partaking of the darkness which preceded, and the light which came after him. He rejected the simple system of Copernicus, and, whether from participating in the religious scruples of his age, or from the

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ambition of appearing as the author of a new system, he restored to the earth its immobility, and placed it in the centre of the motions of the sun and moon. The Tychonic system was an unsuccessful attempt to reconcile the incongruous hypotheses of Ptolemy and Copernicus. It never enjoyed any real estimation; and its followers were only found among those who dreaded the anathemas of the church, or who, belonging to some university or religious corporation, were deprived of the liberty of expressing their real opinions.

Longomontanus, born 1562, died 1647.

Tycho was assisted in his observations at Huen, during eight years, by Longomontanus, who afterwards became professor of the higher mathematics at Copenhagen. This astronomer composed a large work, entitled *Astronomia Danica*, in which he deduced the elements of the different theories from the observations made at Uranibourg, and gave formulæ for computing the planetary motions, according to the three systems of Ptolemy, Copernicus, and Tycho.

Kepler, born 1571, died 1631.

The great mass of accurate observations accumulated by Tycho furnished the materials out of which his disciple Kepler may be said to have constructed the edifice of the world. This great man, the true founder of modern astronomy, was born at Wiel, in the kingdom of Wurtemberg, on the 27th of December 1571. He studied philosophy at Tubingen, and was instructed in mathematics and astronomy by Mœstlin, whose name deserves a place in the history of science, on account of his having been one of the first who had the courage to adopt and to teach the system of Copernicus. The philosophical mind of Kepler, disgusted with the improbabilities and absurdities of the ancient system, received with transport the novel doctrines explained by Mœstlin. The appointment of mathematician to the emperor, which he procured on the death of Stadius, confirmed him in the resolution which he had taken to devote himself to astronomical pursuits; and the energy of his character enabled him in a very short time to make himself thoroughly master of the different hypotheses and principal discoveries which had been made prior to his time. In the year 1596 he published a *Prodromus* of Dissertations on the properties and causes of the celestial orbits, which procured him the friendship of Tycho, and an invitation to take part in the observations and researches of that great astronomer at Prague. On the death of Tycho, which happened soon after, Kepler obtained possession of his invaluable collection of observations, and was charged with the task of completing and publishing the *Rudolphine Tables*.

During his short residence with Tycho, Kepler learned to check the fanciful suggestions of his brilliant imagination, and to draw his conclusions from observations alone, by rigorous and patient induction. The observations of the Danish astronomer had furnished him with the means of establishing with certainty the truth or inaccuracy of the various hypotheses which he successively imagined; and the diligence with which he laboured in comparing and calculating these observations during 20 years, was finally rewarded by some of the most important discoveries which had yet been made in astronomy. Deceived by an opinion which had been adopted by Copernicus, and had never been called in question by the ancients, that all the celestial motions are performed in circles, he long fruitlessly endeavoured to represent, by that hypothesis, the irregular motions of Mars; and after having computed with incredible labour the observations of seven oppositions of that planet, he at length succeeded in breaking down the barrier which had so long obstructed the progress of knowledge, and found that the motions could only be accurately represented by supposing the planet to move in an ellipse, having the sun in one of its foci. Having arrived at this important result, he next proceeded to consider the angular motion of the planet, and finding that it was not uniform in respect of any point situated within the orbit, he concluded that the uniform motion, till then universally received as an axiom, was a vain chimera, which had no existence in nature. He perceived, however, that the areas described by the radius vector of the planet, at its greatest and least distances, were equal in equal times; and subsequent observations enabled him to demonstrate that this equality extended to every point of the orbit. It was therefore discovered that Mars moves in an elliptic orbit, of which the sun occupies a focus, and in such a manner, that the area described by a line drawn from the centre of the planet to that of the sun is always proportional to the time of description. The same conclusions he found to be true in respect of the orbit of the earth; and therefore he could no longer hesitate to extend them by analogy to the other planets. These are two of the three general principles which are known by the name of the *Laws of Kepler*.

It was some years later before Kepler arrived at the knowledge of the analogy which subsists between the distances of the several planets from the sun, and the periods in which they complete their revolutions. To the discovery of this analogy he attached the greatest importance, and regarded all his other labours as incomplete without it. After having imagined numberless hypotheses, it at last occurred to him to compare the different powers of the numbers which express the distances and times of revolutions; and he found, to his infinite satisfaction, that the squares of the periodic times of the planets are always in the same proportion as the cubes of their mean distances from the sun. This is the third law of Kepler. He demonstrated it to be true of all the planets then known. It has been found to be equally true in regard to those which have been since discovered, and likewise to prevail in the systems of the satellites of Jupiter and Saturn. It is indeed, as can be shown mathematically, a necessary consequence of the law of gravitation, directly as the masses, and inversely as the squares of the distances.

By these brilliant discoveries, the solar system was reduced to that degree of beautiful simplicity which had been conceived by Copernicus, but from which that great astronomer had found himself constrained to depart. The sun could not occupy the common centre of the circular orbits, but his place is in the common focus of the elliptic orbits of all the planets; and it is to this focus that every motion is to be referred, and from which every distance is to be measured. The discovery of the elliptic motion, of the proportionality of the areas to the times, and the method of dividing an ellipse, by straight lines drawn from the focus to the periphery, into segments having a given ratio, formed the solution of a problem which had been the constant object of the labours of all astronomers from Ptolemy to Tycho, namely, to assign the place of a planet at any instant of time whatever. The tables which he computed for the elliptic motions form the model of those in present use. Some additions have been made in consequence of the perturbations, which the geometry of Kepler was inadequate to estimate, and which were only partially detected by the genius of Newton. It has been considered matter of surprise that Kepler did not think of extending the laws of the elliptic motion to the comets. Prepossessed with the idea that they never return after their passage to the sun, he imagined that it would only be a waste of time to attempt the calculation of the orbits of bodies which had so transitory an existence. He supposed

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the tail to be produced by the action of the solar rays, which, in traversing the body of the comet, continually carry off the most subtile particles, so that the whole mass must be ultimately annihilated by the successive detachment of the particles. He therefore neglected to study their motions, and left to others a share of the glory resulting from the discovery of the true paths of the celestial bodies.

The observations of eclipses had formed the principal object of the earliest astronomers, but it was Kepler who first showed the practical advantages which may be derived from them, by giving an example of the method of calculating a difference of meridians from an eclipse of the sun. The method extends to occultations of the stars, and is deservedly considered as the best we possess for determining geographical longitudes and correcting the tables. He composed a work on optics, replete with new and interesting views, and gave the first idea of the telescope with two convex glasses, which has since been advantageously substituted for that of Galileo. Prompt to seize every happy idea of his contemporaries, he perceived with delight the advantages which practical astronomy would derive from the new invention of the logarithms, and he immediately constructed a table, from which the logarithms of the natural numbers, sines, and tangents could be taken at once.

Kepler was not merely an observer and calculator; he inquired with great diligence into the physical causes of every phenomenon, and made a near approach to the discovery of that great principle which maintains and regulates the planetary motions. He possessed some very sound and accurate notions of the nature of gravity, but unfortunately conceived it to diminish simply in proportion to the distance, although he had demonstrated that the intensity of light is reciprocally proportional to the surface over which it is spread, or inversely as the square of the distance from the luminous body. In his famous work *De Stella Martis*, which contains the discovery of the laws of the planetary motions, he distinctly states that gravity is a corporeal affection, reciprocal between two bodies of the same kind, which tends, like the action of the magnet, to bring them together, so that when the earth attracts a stone, the stone at the same time attracts the earth, but by a force feebler in proportion as it contains a smaller quantity of matter. Further, if the moon and the earth were not retained in their respective orbits by an animal or other equipollent force, the earth would mount towards the moon one fifty-fourth part of the interval which separates them, and the moon would descend the fifty-three remaining parts, supposing each to have the same density. He likewise very clearly explains the cause of the tides in the following passage. "If the earth ceased to attract its waters, the whole sea would mount up and unite itself with the moon. The sphere of the attracting force of the moon extends even to the earth, and draws the waters towards the torrid zone, so that they rise to the point which has the moon in the zenith." It is not difficult to imagine how much these views must have contributed to the immortal discovery of Newton.

It is afflicting to consider how frequently the just rewards of true merit are usurped by charlatanism and pretension. While the fire-eaters and astrologers of Rudolph were basking in the sunshine of imperial favour, Kepler, from whose labours the sciences derived the most signal benefits, passed his life in extreme indigence. Born without fortune, the only revenue he possessed, and out of which he had to maintain a numerous family, arose from the precarious produce of his writings, and his pension of mathematician to the emperor,—a pension which, owing to the calamities of the times, was seldom duly paid. On this account he was obliged to prefer frequent solicitations, and undertake long journeys, whereby he lost his time, always precious to genius, and exhausted his mind in anxiety. He died on the 15th of November 1630, at Ratisbon, whither he had gone to solicit the arrears that were due to him. In the present century a marble monument has been erected to his memory by an enlightened prince, Charles of Alberg. It contains his bust and the ellipse of Mars; a monument more glorious and more imperishable than brass or marble.

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Galileo, born 1564, died 1642.

Contemporary with Kepler was the illustrious Galileo, whose discoveries, being of a more popular nature, and far more striking and intelligible to the generality of mankind, had a much greater immediate effect on the opinions of the age, and in hastening the revolution which was soon about to change the whole face of physics and astronomy. Galileo-Galilei, a Florentine patrician, was born at Florence in the year 1564. He passed his youth at Venice, where he continued till he was appointed to a professor's chair at Padua. After a residence of eighteen years in that city, he was induced to remove to Pisa by Cosmo II., who assigned him a pension, and conferred on him the title of his first mathematician. While residing at Venice, he heard it reported that Metius, a Dutch optician, had discovered a certain combination of lenses, by means of which distant objects were approximated to the sight. This vague and scanty intelligence sufficed to excite the curiosity of Galileo, who immediately set about inquiring into the means whereby such an effect could be produced. His researches were attended with prompt success, and on the following day he had a telescope which magnified about three times. It was formed by the combination of two lenses, a plano-convex and plano-concave, fitted in a leaden tube. In a second trial he obtained one which magnified seven or eight times; and subsequent essays enabled him to increase the magnifying power to 32 times. On directing his telescope to the moon, he perceived numerous inequalities on her surface, the diversified appearances of which led him to conclude almost with certainty that the moon is an opaque body similar to the earth, and reflecting the light of the sun unequally, in consequence of her superficial asperities. The planet Venus exhibited phases perfectly similar to those of the moon. These phases had been formerly announced by Copernicus as a necessary consequence of his system; and the actual discovery of their existence made it impossible to doubt of the revolution of Venus round the sun. He detected the four satellites or moons of Jupiter, and, in honour of his patron, gave them the name of the *Medicean Stars*. The discovery of these little bodies circulating round the huge orb of Jupiter afforded him a strong analogical proof of the annual revolution of the earth, accompanied by its moon. He perceived spots on the disk of the sun, from the motions of which he concluded the rotation of that body about its axis in the space of 27 days. The singular appearances of Saturn were beheld by him with no less pleasure than astonishment. His telescope was not sufficiently powerful to separate the ring from the body of the planet; and to explain the appearances he supposed Saturn to be composed of three stars almost in contact with one another. These discoveries proved that the substances of the celestial bodies are similar to that of the earth, and demolished the Aristotelian doctrine of their divine essence and incorruptible nature. They enlarged the ideas of mankind respecting the planetary system, and furnished the most convincing arguments in favour of the doctrines of Copernicus.

The discoveries of Galileo excited the envy of his

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contemporaries, and stirred up against him a persecution which embittered the last days of his life. The motion of the earth, which he had proved so triumphantly, was considered contrary to many express declarations of Scripture; it was also considered as a heresy in the schools, where the doctrines of Aristotle were followed with implicit submission. In defending the Copernican system, Galileo had incurred the bitterest resentment, both of theologians and peripatetics. His great reputation, his title of professor and first mathematician, gave them reason to dread that the new doctrines, recommended by such an advocate, would spread too rapidly, and finally overthrow the altars of Aristotle. They therefore combined to check their progress, and to procure the ruin of Galileo by injurious representatives to the Grand Duke and the court of Rome. Soon after his first telescopic discoveries he was cited to appear before the Inquisition, and a promise extorted from him that he would never, either by word or writing, support the opinion of the motion of the earth. But in a great mind the love of truth is the most imperious of all passions, and cannot be restrained by the frowns of despotism, or the persecution of a fanatical tribunal. The evidences of the motion of the earth burst forth from every point of the heavens; and Galileo, in his celebrated *Dialogues* on the system of the world, exposed them in so clear and forcible a manner, that, although he appeared to put them forth for the purpose of refuting them, it was not difficult to perceive that he regarded them as complete and indubitable. For this relapse into heresy he was again brought before the tribunal of the Inquisition, and, in the seventieth year of his age, condemned formally to retract and abjure the doctrine of the earth's motion, and to be imprisoned during the pleasure of the Inquisition. This scandalous proceeding has called forth the indignant reprobation of every lover of truth and freedom. "What a spectacle," exclaims Bailly, "an old man, whose hairs were blanched with study, watchings, and benefits to mankind, on his knees before the sacred Scriptures, abjuring the truth in the eyes of Italy, which he had enlightened, in opposition to the testimony of his conscience, and in spite of the manifestations given by nature through all her works."

The sentence passed on Galileo was not inflicted with great severity. At the end of a year the Grand Duke had the influence to procure his release from prison; but he was prohibited from returning to Florence, and obliged to confine himself to the Tuscan territory. He retired to the village of Arcetri, where he resumed his observations, and shortly afterwards discovered the libration of the moon. The satellites of Jupiter continued also to engage his attention, and he commenced a table of their motions, and pointed out the method of determining the longitude by means of their eclipses. The states of Holland, aware of the great benefit of his researches to commerce and navigation, sent two astronomers, Hortensius and Blaeu, to present him with a gold chain, and encourage him to persevere in his useful labours. A short time after receiving this honourable mark of esteem from a foreign country, Galileo suddenly became blind; and the task of forming the tables of the satellites was reserved for Cassini. He survived this misfortune only a few years, and expired in 1642, in the seventy-eighth year of his age.

Science is indebted to Galileo for two other discoveries of a different kind, less brilliant perhaps, but of far greater importance than those which we have yet enumerated. These are the isochronism of the vibrations of the pendulum, and the law of the acceleration of falling bodies. His telescopic discoveries could not have remained long unknown; in fact, with the exception of those of the phases of Venus, and of the triple form of Saturn, they were all fiercely disputed, even during his own lifetime. It is now universally admitted that he was the first who discovered the satellites of Jupiter, and the spots of the sun; but the very circumstance of other claimants to these discoveries having arisen, proves that they were within the reach of ordinary attention. No one ever thought of disputing with Kepler the discovery of the laws of the planetary motions. Those of Galileo required only eyes, and may be regarded as following of course from the discovery of the telescope; but his persecution, his condemnation, and his being compelled to retract and abjure a doctrine of which he had given the physical proof, inspire a hallowed interest in his history, and contributed much to the great reputation which he acquired throughout Europe.

Logarithms invented, 1614.

While astronomy was making these rapid advances in the hands of Kepler and Galileo, an event occurred in Scotland which contributed, though less directly, no less powerfully, to the acceleration of its progress. This was the invention of the logarithms by Lord Napier, baron of Merchiston; "an admirable artifice," says Laplace, "which, by reducing to a few days the labour of many months, doubles the life of the astronomer, and spares him the errors and disgust inseparable from long calculations; an invention of which the human mind has the more reason to be proud, inasmuch as it was derived exclusively from its own resources." It may be added, that without this, or some equivalent artifice, the computations rendered necessary by more correct observations would far exceed the limits of human patience or industry, and astronomy could never have acquired that precision and accuracy by which it is now distinguished above all the other branches of human knowledge.

Labours of different astronomers.

The same epoch presents to us a great number of excellent observers, who, although they did not produce any revolution in the state of astronomy, still rendered it useful service. Scheiner is celebrated for his observations on the solar spots, and his disputes with Galileo. John Bayer of Augsburg published a description of the constellations, accompanied by maps, in which the stars are marked by a Greek letter; a simple idea, which has been universally adopted. Lansberg, a Flemish mathematician, published in 1632 a set of astronomical tables, which, though filled with inaccuracies, rendered good service to science by apprizing Horrox of the transit of Venus over the sun's disk, which that young astronomer and his friend Crabtree had the satisfaction of observing on the 24th of November 1639. They were the first who ever witnessed that interesting but rare phenomenon. Snellius is celebrated for his measure of the earth. Gassendi, who had the merit, along with Descartes, of hastening the downfall of the Aristotelian philosophy in France, made some useful observations, particularly one of a transit of Mercury in 1631. His works, which fill six folio volumes, abound with curious and useful researches. Riccioli, a Jesuit, born at Ferrara in 1598, contributed to the progress of astronomy, not so much by his own discoveries, as by collecting and rendering an account of those of others. He rejected the system of Copernicus, and was more zealous in maintaining the doctrines of the church than in investigating nature; but his works form a vast repertory of useful information. His *Novum Almagestum* is a collection of the observations, opinions, and physical explanations of the phenomena, together with all the methods of computation then known. He was assisted in his labours by Grimaldi, who discovered the inflection of light, and gave the names to the principal spots of the moon which are now used by astronomers.

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Hevelius, born 1611. died 1687.

The most accurate observations that were ever made prior to the adaptation of the telescope to astronomical instruments were those of Hevelius, a rich citizen of Dantzic, who devoted his life and a large fortune to the service of astronomy. Having fitted up an observatory, and furnished it with the best instruments which could be procured, he commenced a course of observations, which he followed assiduously upwards of forty years. In his *Selenographia* he has given an accurate description of the face and spots of the moon, accompanied with excellent delineations of her appearance in her different phases and librations. The idea of making drawings of the different phases of the moon had previously occurred to Gassendi and Peiresc, but they had not been able to execute the project; indeed the difficulty attending it was such, that it occupied Hevelius, who was an excellent draughtsman, as well as observer, during a great number of years. Hevelius made an immense number of researches on comets; and finding that the observations could not be represented by rectilinear or circular orbits, he supposed them to move in parabolas. During a temporary absence from Dantzic, this indefatigable astronomer had the misfortune to lose, in a great fire which occurred in the city, his observatory, instruments, manuscripts, and almost the entire edition of the second volume of his *Machina Cœlestis*, which contained the results of his long labours and numerous observations. He was now in his old age, but his zeal did not give way under the terrible calamity. He patiently recommenced all his calculations, reconstructed tables of the sun, and prepared for publication his *Firmamentum Sobiescianum*, or celestial chart, which did not appear till after his death. Towards the latter part of his life, the use of telescopic sights began to be generally adopted. Hevelius, however, resisted the innovation, and continued to employ plain sights. This preference given to the ancient method by so skilful an observer induced Dr Halley to visit him at Dantzic, for the purpose of ascertaining, by a comparison of observations made at the same time and place, which of the two methods gave the most correct results. Dr Halley observed with the telescope, and Hevelius with his own instruments; but such was the dexterity he had acquired through long practice, that the difference of their observations seldom amounted to more than a few seconds, and in no case to so much as a minute. Notwithstanding this agreement, it is to be regretted that Hevelius did not adopt the new method; for, on account of the greater precision given to instruments by the use of the telescope, his observations, which were made without it, cannot now be admitted in the construction of tables, and consequently are for the most part useless to astronomy.

Huygens, born 1629, died 1695.

Few individuals have rendered more important services to science than Huygens. Born at the Hague in 1629, he studied geometry under Schooten, the commentator of Descartes, and gave early proofs of proficiency in that science by a treatise on the quadrature of the conic sections. Having passed into France, he studied law at the university of Angers; but his principal attention was directed to the physical sciences, particularly to optics. He employed himself in grinding and polishing lenses; and constructed a telescope of ten feet, with which he discovered one of the satellites of Saturn. His application of the pendulum to clocks deserves to be considered as one of the best gifts which genius has ever conferred on science. He seems to have conceived the idea of this application in 1656; and he presented the first description of the pendulum clock to the states of Holland in 1657. He endeavoured to make this invention subservient to the problem of the longitudes; and if his efforts were not attended with the desired success, it may be said, that without another invention, in which also he had a principal share, that of the spiral spring, the object would never have been accomplished so nearly as it was a hundred years later. By means of his excellent telescopes he discovered that the extraordinary appearance exhibited by Saturn was occasioned by a ring surrounding the body of the planet, and inclined to the ecliptic in an angle which he estimated at 21°. He published his observations on this planet in a work entitled *Systema Saturnium*, which still shows some traces of that species of reasoning from final causes which so greatly disfigures the writings of Kepler. For example, on discovering the satellite, he conceived that as the number of satellites now equalled the number of planets, it was in vain to look for more, the equality being necessary to the harmony of the system. He lived, however, to witness the discovery of four more satellites belonging to the same planet. Huygens was invited to settle in France by Colbert, the patriotic minister of Louis XIV., who assigned him a pension and a seat in the academy of sciences. He continued in that country till the revocation of the edict of Nantz in 1681, when he resigned his pension and retired to Holland. After this he contributed several papers to the *Philosophical Transactions*, and in 1690 published a treatise on light and gravitation. Geometry, mechanics, and optics, are indebted to the genius of Huygens for many important discoveries. His theorems on central forces, his researches on the doctrine of probabilities and continued fractions, and his theory of involutes and evolutes, raise him to the highest rank among the mathematicians of his age. He died on the 8th of June 1695, at the age of 66 years.

Telescopes applied to quadrants, 1667.

The application of telescopes and micrometers to graduated instruments forms an important epoch in the history of astronomy. This happy improvement was first brought into use by Picard in 1667. Morin, indeed, had applied a telescope to the quadrant so early as 1634, and *perceived* the stars in full day in 1635. In 1669 Picard began to observe the stars on the meridian in the daytime, with a quadrant, to which, in concert with Azout, he had applied an astronomical telescope having cross wires in its focus. Huygens invented the plate micrometer in 1650; Malvasia that with the fixed wires in 1662; and Azout that with the movable wire in 1666. (See Delambre, *Astronomie du Moyen Age*, p. 618. Note by Bouvard.) It is principally to the happy discoveries and ingenious inventions just referred to, and the fine application of the pendulum to clocks by Huygens in 1656, that we must attribute the rapid progress since made in practical astronomy, and the extreme precision of modern observations. Picard was also the first who introduced the modern method of determining the right ascensions of the stars, by observing their meridional passages, and employed the pendulum for that purpose. He likewise introduced the method of corresponding altitudes, and is entitled to be regarded as the founder of modern astronomy in France.

Roemer, the friend and pupil of Picard, discovered the progressive motion of light in 1675, and measured its velocity by means of the eclipses of Jupiter's satellites. He was the first who erected a transit instrument, which gave a new accuracy to observations of right ascension.

Dominic Cassini, born 1625 died 1712.

The Royal Observatory of Paris was completed in 1670, and its direction intrusted to Dominic Cassini. This celebrated astronomer was born at Perinaldo, in the county of Nice, and educated in a college of the Jesuits at Genoa. He acquired an early passion for astronomical observations; and in 1644 was invited to Bologna by the marquis Malvasia, where, in 1650, he succeeded Cavalleri

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as professor of astronomy. In this situation he continued till 1669, when he went to Paris on the invitation of Louis XIV. He was naturalized in France in 1673, and continued in the charge of the observatory till his death, which happened in 1712.

Cassini enriched astronomy with a great number of curious observations and discoveries. He determined the motions of Jupiter's satellites from observations of their eclipses, and constructed tables of them, which were found to be remarkably exact. He observed that the ring of Saturn is double, and discovered four of the satellites of that planet. He also determined the rotation of Jupiter and Mars, and made a number of observations on Venus with the same view. He observed the zodiacal light, and made a near approximation to the parallax of the sun. We also owe to him the first table of refractions, calculated on correct principles; and a complete theory of the libration of the moon. Galileo had only observed the libration in latitude; Hevelius explained the libration in longitude, by supposing that the moon always presents the same face to the centre of her orbit, of which the earth occupies a focus. Cassini made the important remark, that the axis of rotation of the moon is inclined to the ecliptic, and that its nodes coincide with those of the lunar orbit, so that the poles of the orbit, ecliptic, and equator of the moon, are on the same circle of latitude, the pole of the ecliptic being situated between the other two. The greater number of these discoveries are, however, only of secondary importance; and it must be confessed that Cassini took no part in the great and permanent improvements which astronomy received in that age. He has, nevertheless, obtained an extraordinary reputation. Lalande remarks, that in his hands astronomy underwent the most signal revolutions, and that his name is, in France, almost synonymous with that of creator of the science. Delambre has, however, taken a different and far more accurate view of the real services of Cassini. "The revolution in Astronomy," this judicious critic observes, "was brought about by Copernicus, by the laws of Kepler, by the pendulum of Huygens, the micrometers of Azout and Picard, by the sectors and mural of Picard, and his method of corresponding altitudes, by the transit instruments of Roemer; and Cassini appears to us an entire stranger to all these innovations. He followed another route; he devoted a long life to painful observations, which at last deprived him of sight. Let us not refuse him the praise which he has so well merited, but let us reserve a place in our esteem for labours less brilliant perhaps, but of greater and more permanent utility, and which evince at least equal talent and sagacity."

Maraldi.

Cassini was assisted in his observations by his nephew, James Philip Maraldi, who determined the regression of the nodes, and the progressive motion of the apsides of the orbit of Jupiter. This astronomer also corrected the theory of Mars, and observed the sun's parallax. He rejected the hypothesis of the progressive motion of light, as being insufficient to explain the inequalities of Jupiter's satellites; and he conceived the design of forming a new catalogue of the stars, which, however, was never executed. He died in 1729.

Progress of science in the 17th century.

There is no period in the history of mankind so distinguished by great and important discoveries, or so remarkable for the rapid development of the human intellect, as the seventeenth century. We have already noticed the invention of the pendulum, and its application to regulate the motion of time-keepers; of the telescope, and some of the phenomena of the new worlds it has exposed to view; of the logarithms, by which computations are so much abridged; and of the mechanical contrivances for measuring minute angles in the heavens. The same century witnessed the application of algebra to geometry, the discovery of the laws of the planetary motions, of the infinitesimal calculus, the acceleration of falling bodies, the sublime theory of central forces, and the great principle of gravitation which connects the celestial orbs, and regulates the motions which it had been the business of the astronomer to observe since the earliest ages of the world. The different steps which conducted to this important discovery, and the immediate consequences deduced from it by its immortal author, are so fully developed in the admirable Dissertation on the Progress of the Physical Sciences, in this Encyclopædia, that it is unnecessary to enter into any detail respecting them here; we may only remark, that if observation has furnished the data for the discovery of the mechanical principle and primordial laws of the universe, the knowledge of these laws has been, in turn, of the most essential service to observation, by guiding and directing it to its most important objects. Many of the inequalities of the planetary motions, in consequence of their minuteness and the slowness with which they vary, could not have been detected by observation; others might perhaps have been perceived, but we should still have been ignorant whether their constant accumulation might not ultimately change the state of the system, and, by destroying all confidence in the tables, demolish the fabric which had been reared at such a vast expense of time and labour. But when these inequalities are detected by theory, and separated from the mean motions with which they were blended, it becomes an object of the highest interest to confirm their existence by the most delicate and accurate observations. Hence, a more refined practice has constantly followed every theoretical discovery. Besides, it is the perfection of theory, and not the mere knowledge of isolated facts, which gives astronomy its greatest value in the eyes of the philosopher. Numerous and important as its applications are, they have but a subordinate interest, in comparison of the knowledge of those general laws to which every particle of matter in the universe is subject, and by the discovery of which man has penetrated so deeply into the mysteries of nature.

Discoveries of Newton, born 1642, died 1727.

By the discovery of the law of gravity Newton laid the foundations of physical astronomy; and by the consequences which he deduced from that law, proceeded far in the erection of the superstructure. He showed that the motions of all the bodies of the planetary system are regulated by its influence; he determined the figure of the earth on the supposition of its homogeneity; he gave a theory of the tides, discovered the cause of the precession of the equinoxes, and determined some of the principal lunar inequalities and planetary perturbations. Many of his theories were left in an imperfect state; for it is not in matters of science that it is given to the same individual to invent and bring to perfection: their complete development required that several subsidiary sciences should be farther advanced; but it has been the triumph of his system, that every subsequent discovery has only tended to strengthen and confirm it. This bright ornament of the human genius was born on the 25th of December 1642, the day of the death of Galileo, and died on the 20th of March 1727, in the 85th year of his age.

Flamsteed, born 1646, died 1719.

While physical astronomy was undergoing a complete revolution in the hands of Newton, the practical part was receiving great improvement from Flamsteed, the first astronomer royal, who conducted the Greenwich Observatory. This celebrated institution, from which so many important discoveries have emanated, was erected under the reign of Charles II, in 1675. Flamsteed was appoint-

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ed to it in 1676, and continued with indefatigable zeal to discharge the duties of the office during the long period of 33 years. In the course of this time he made an immense number of excellent observations, the results of which are given in the *Historia Cœlestis*, the first edition of which was published in 1712, at the expense of Prince George of Denmark, the husband of Queen Anne. The second appeared in 1723, some time after the death of the author, in three volumes folio. The first volume contains the observations which he made, first at Derby, and afterwards at Greenwich, on the fixed stars, planets, comets, spots of the sun, and Jupiter's satellites. The second volume contains the transits of the planets and stars over the meridian, and the places of the planets deduced from these observations. The third contains an historical notice, in which he gives a description of the instruments used by Tycho and himself; catalogues of fixed stars by Ptolemy, Ulugh Beigh, Tycho, the landgrave of Hesse, and Hevelius; together with the British Catalogue, containing the places of 2884 stars. The labours of Flamsteed were, however, confined entirely to the practical part of astronomy. He made no improvements in theory; but he is entitled to the merit of having been the first who brought into common use the method of simultaneously observing the right ascension of the sun and a star, a method by means of which the determination of the positions of the stars is reduced to the observation of meridional transits and altitudes. He was likewise the first who explained the true principles of the equation of time; and he improved the lunar tables by introducing into them the annual equation which had been suggested by Horrox. The *Atlas Cœlestis*, another posthumous work of Flamsteed, was published in 1753.

Halley, born 1656, died 1742.

Flamsteed was succeeded in the observatory by Dr Halley, a philosopher whose inventive genius and indefatigable activity rendered him one of the brightest ornaments of his country. Halley was the son of a wealthy citizen of London, where he was born on the 8th of November 1656. From his earliest years he applied himself with ardour to the study of mathematics and astronomy; and having procured a few instruments, he began to make observations, by which he was led to remark the inaccuracy of the tables of Jupiter and Saturn. In his 19th year he published a direct and geometrical method of finding the eccentricities and aphelia of the orbits of the planets; and in the year following he undertook a voyage to St Helena, with a view to form a catalogue of the stars in the southern hemisphere. The station was unfortunately chosen, for, owing to the incessant rains and foggy atmosphere of that island, he was able to determine the places of only 360 stars in the course of a whole year. He had, however, the satisfaction of observing a transit of Mercury over the sun's disk, a phenomenon which suggested to him the important remark, that the transits of the inferior planets might be advantageously employed in determining one of the most essential elements of the planetary system, viz. the parallax of the sun, and consequently the diameters of the orbits. The method has since been successfully employed in the case of Venus: the transits of Mercury, though much more frequent, are not so well adapted to the purpose. On his return from St Helena he was commissioned by the Royal Society to visit Hevelius at Dantzic, and determine, by a direct comparison of observations, the dispute which had arisen between that astronomer and Dr Hooke respecting the relative advantages of plain and telescopic sights. After this Halley for some time travelled on the Continent, and on his return to England devoted himself entirely to scientific pursuits. The fruits of his leisure soon began to appear in the multitude of treatises which he published from time to time in every department of the mathematical and physical sciences. The most important of those connected with astronomy was his *Synopsis Astronomiæ Cometicæ*,—a work abounding in profound and original views, and which, in respect of theory, formed perhaps the most remarkable accession to the science that had been made since the time of Kepler. In this work he revived an ancient opinion, that the comets belong to the solar system, and move in very eccentric orbits round the sun, returning after stated but long intervals. He also ventured to predict that the comet of 1681 would again return to its perihelion in 1759,—the first prediction of the kind that was verified. In 1720 Dr Halley was appointed to succeed Flamsteed in the Royal Observatory; and though now in the 64th year of his age, he undertook, with a view to improve the lunar theory, to observe the moon through a whole revolution of her nodes, erroneously supposing, that after such a revolution the errors of the tables would again appear in the same order. He was the first who, by a comparison of ancient and modern observations, remarked the acceleration of the mean motion of the moon, and thus called the attention of mathematicians to an important and curious phenomenon, the physical cause of which was at length detected by the powerful analysis of Laplace. He was also the first who pointed out the secular inequalities of Jupiter and Saturn, occasioned by their mutual perturbations,—a theory that formed the subject of several profound memoirs of Euler and Lagrange, and for the complete development of which astronomy is likewise indebted to Laplace. Besides these important discoveries in astronomy, the labours of Dr Halley also greatly contributed to the promotion of geometry and navigation. He undertook two long voyages, and traversed the Pacific Ocean to observe the deviations of the magnetic needle; and posterity will gratefully recollect that it was through his pressing solicitations that Newton consented to the publication of the *Principia*. In 1703 he succeeded Dr Wallis as professor of geometry at Oxford. He became secretary of the Royal Society in 1713, and died at Greenwich in 1742.

Bradley, born 1692, died 1762.

The discoveries of Bradley, who succeeded Halley as astronomer-royal, form a memorable epoch in the history of the science. This great astronomer was born at Sherborne in Gloucestershire in 1692, and acquired from his uncle, Mr Pound, an early taste for astronomical observation. He was destined for the church, and for some time held a curacy, which he resigned in 1721, on being appointed to succeed Keill as Savilian professor of astronomy at Oxford. His first essays indicated no extraordinary talent; but an opportunity having presented itself of engaging in more important researches, he embraced it with ardour; and by his sagacity and perseverance was conducted to two discoveries which have entirely changed the face of astronomy.

Discovery of the aberration of light.

A singular motion of the polar star had been observed by Picard, of which, however, that astronomer could neither assign the law nor give any satisfactory explanation. He only remarked that the inequality was annual, and amounted to about 40 seconds. Hooke, in 1674, a few years after the observations of Picard, imagined that he had discovered a parallax in some of the stars; and Flamsteed, following the ideas of Hooke, explained, by means of parallax, the minute changes of position which he had observed in Polaris and some circumpolar stars. Manfredi and Cassini demonstrated the error of Flamsteed, but were not more successful in their attempts to explain the motion in question. Samuel Molyneux conceived the idea of verifying all that had been said respecting the

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supposed parallaxes, and for this purpose commenced a series of observations at Kew, with an excellent 24 feet sector constructed by Graham. Bradley, who happened at that time to reside at Kew, took a part in these observations, the result of which was, that the remarks of Picard were confirmed beyond the possibility of doubt. It was, however, abundantly evident that the apparent motions alluded to were not connected in any manner with parallax; it therefore became an object of the greatest interest to determine their physical cause, and assign their law and period. The first idea that occurred was to inquire whether they arose from a change of position in the earth's axis; but this supposition was found to be inadequate to the explanation of the phenomena. Molyneux having been in the mean time appointed a lord of the admiralty, the observations were discontinued at Kew; they were, however, shortly after resumed by Bradley at Wanstead, with a smaller but more convenient instrument; and after they had been continued several years, it was found that the star (γ draconis) on which they were principally made, appeared to describe annually a small ellipse, the transverse axis of which amounted to 40″. This was an important determination; for the ellipse afforded the means of computing at all times the aberration of any star whatever, whether in longitude, latitude, declination, or right ascension. Bradley also pointed out the physical cause of the aberration, and demonstrated that it resulted from the combination of the motion of light with the annual motion of the earth. This capital discovery was made in 1728.

Discovery of the nutation of the terrestrial axis.

Bradley, anxious to verify his ingenious theory, continued his observations, and soon felt the difficulty that had so much embarrassed Picard. The places of the stars, calculated according to his formula for the aberration, could not be reconciled with the observations. The errors continued to augment during nine years, after which they went on diminishing during the nine years following. This inequality, of which the period, like that of the nodes of the moon, was 18 years, was readily explained by supposing a slight oscillation of the earth's axis, occasioned by the action of the moon on the protuberant parts surrounding the equator of the terrestrial spheroid. After assiduously observing its effects during twenty years, Bradley found that the phenomena could be accurately represented by giving the pole of the equator a retrograde motion about its mean place in an ellipse whose axes are 18″ and 16″, and completing its revolution in the period of 18 years. This result was communicated to the Royal Society in 1748. To these two grand discoveries of Bradley, the aberration and nutation, modern astronomy is wholly indebted for all its accuracy and precision; and, as Delambre remarks, they assure to their author a distinguished place, after Hipparchus and Kepler, above the astronomers of all ages and all countries.

Bradley was appointed astronomer royal in 1741, and from this time to the period of his death made an immense number of observations, which were presented by his heirs to the university of Oxford, on condition that they should forthwith be published. The first volume appeared only in 1798, edited by Dr Hornsby. The rest were committed to the care of the late Dr Abraham Robertson, and appeared in 1805. Dr Bradley was chosen a corresponding member of the Academy of Sciences in 1748. In 1752, twenty-four years after his great discovery of the aberration of light, he was admitted into the Royal Society. He died on the 13th of July 1762, in the 70th year of his age.

While England was deriving so much glory from the brilliant discoveries of Bradley, France produced a multitude of excellent astronomers, by whose successful labours every department of the science was signally promoted. Among these Lacaille is pre-eminently distinguished, both by the variety and importance of his observations, and the indefatigable zeal with which, during twenty-two years, he prosecuted the most laborious researches. He commenced his astronomical career in 1739, by assisting Cassini de Thury (grandson of the first Cassini) in the verification of the measurement of the meridian through France. In 1751 he undertook a voyage to the Cape of Good Hope, the primary objects of which were to determine the sun's parallax, by means of observations on the parallaxes of Mars and Venus, while similar observations were made in Europe; and to form a catalogue of the southern circumpolar stars. No undertaking for the benefit of science was ever more successfully executed. In the course of a single year, Lacaille, without assistance, observed upwards of ten thousand stars, situated between the tropic of Capricorn and the pole, and computed the places of 1942 of them; a labour which would scarcely be credited, if the details of his observations had not been published in the *Cœlum Australe Stelliferum*, a work which was given to the world in 1763. Our admiration of the rapid execution of this vast undertaking will be increased, when we consider, that during the same time he measured a degree of the meridian, and made numerous observations on the moon simultaneous with those of Lalande, who observed at Berlin, in order to determine the moon's parallax, by means of direct observations made at the extremities of a meridional arc of upwards of 85 degrees. Before his return to Europe, he visited the isles of France and Bourbon, where he measured the length of the pendulum, and made numerous remarks on the natural and civil history of those countries. Astronomy is likewise indebted to Lacaille for a table of refractions which he computed from a comparison of above 300 observations made at the Cape and at Paris. In 1757 he published his *Astronomiæ Fundamenta*, in which he gave rules and tables for computing the apparent motions of the stars, which continued to be employed till Lambert supplied the corrections depending on the nutation, and Delambre those depending on the aberration. To defray the expense attending the publication of this important work, which he distributed in presents to the different observatories and astronomers in Europe, he submitted to the drudgery of calculating ephemerides during ten years. Lacaille composed several elementary works for the use of the students in the college of Mazarin, where he occupied the chair of astronomy, and inserted a great number of memoirs in the volumes of the Academy of Sciences. This great astronomer, distinguished as much by the excellence of his moral qualities as his profound knowledge and indefatigable zeal, died suddenly in 1762.

Lacaille, born 1713, died 1762.

Cassini II. born 1677 died 1756.

The Royal Observatory of Paris continued under the direction of the family of Dominic Cassini during 120 years. James Cassini, the second of that name, is principally known by a work on the magnitude and figure of the earth, and his *Elements of Astronomy*. He seems not to have duly appreciated the new discoveries which were daily making around him. His *Elements*, published in 1740, contains no mention of the aberration; and he adopted the opinion that the earth is elongated instead of being flattened at the poles. His son, Cassini de Thury, was chiefly occupied with the meridian, and the geometrical survey of France. The last astronomer of the family, the Count de Cassini, was obliged to resign the observatory at the revolution.

Measurement of the earth.

The question of the figure of the earth furnished ample materials for the practical as well as the speculative as-

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tronomer during the last century. The results of the measurement of the meridian by Cassini were at variance with the theories of Newton and Huygens; and the Academy of Sciences resolved on making a decisive experiment by the actual measurement of the lengths of two degrees, one at the equator, and another in as high a latitude as could be reached. In the year 1735, three astronomers, Godin, Bouguer, and La Condamine, were commissioned by the French government to accomplish the first of these objects in Peru; and the year following, Maupertuis, Clairaut, Camus, and Lemonnier, went to Lapland to execute the second under the polar circle. Notwithstanding the greater difficulties they had to contend with, the first party were the most successful; but the result of both operations established the compression of the earth at the poles. Bouguer published the details of the Peruvian measurement in an admirable work on the *Figure of the Earth*, in which he has also inserted an account of a great number of experiments made by him in the same country to determine the length of the seconds' pendulum, and the effects of the attraction of mountains on the plumb-line. Bouguer is likewise the author of an excellent treatise on light. This accomplished mathematician and experimenter did not adopt the Newtonian theory of gravitation, but he was the last apostle of the Cartesian philosophy in the Academy of Sciences.

It would greatly exceed the limits of this article to give even an abridged account of the numerous observers who, about this period, contributed to the improvement of every department of practical astronomy. We must therefore content ourselves with merely noticing the names of some of the most distinguished, leaving the details of their labours to be given in the biographical articles interspersed throughout the work.

Delisle, born 1688, died 1768.

Delisle formed a school of astronomy in Russia, and has left a method of computing the heliocentric places of the sun's spots, and of Mercury and Venus in their transits over the sun's disk, and likewise of determining, by means of the stereographic projection, the directions of their path when they enter and leave the disk. Lemonnier introduced the discoveries of Bradley into his *Astronomical Institutions*, and was the instructor of Lacaille and Lalande. He published a *Histoire Céleste*, containing a collection of observations from 1666 to 1685, and a number of other works and memoirs connected with astronomy. He made an immense number of observations, but their accuracy is far inferior to those of Bradley. Wargentin, secretary of the Academy of Sciences of Stockholm, devoted the whole of his life to the correction of the tables of the satellites of Jupiter. The theory of the satellites was not then far advanced; but when theory failed him, he profited by the remarks of others and by his own reflections, and endeavoured by repeated trials to find empirical equations capable of conciliating the tables with the best observations. By confining himself almost exclusively to this subject, he acquired a high reputation, and was ranked among the first astronomers of an epoch which abounds in great names. His tables of the satellites have, on account of their superior accuracy, been employed in determining the masses, and other elements, which serve as the basis of the analytical theories.

Lemonnier, died 1799.

Wargentin, born 1717, died 1783.

Lalande, born 1732, died 1807.

One of the most celebrated astronomers of the last century was Lalande. He commenced his early career by a set of lunar observations at Berlin, undertaken simultaneously with those of Lacaille at the Cape, for the purpose of determining the moon's horizontal parallax. On his return to Paris he was received, though only twenty-one years of age, into the Academy of Sciences; and on the resignation of Delisle was appointed professor of astronomy in the college of France. By his extraordinary zeal, indefatigable activity, and the care which he took to have his name constantly before the public, Lalande soon became one of the most distinguished men of his day; but his reputation, acquired in a great measure from attention to subjects which had only an ephemeral interest, and not through any permanent or fundamental additions to science, has already begun to wane; and his works, many of which are of considerable utility, seem to have fallen into unmerited neglect. His character as an astronomer is fairly and impartially summed up by Delambre in the following terms:—"If Lalande did not renew the foundations of astronomical science, like Copernicus and Kepler,—if he did not, like Bradley, immortalize himself by two brilliant discoveries,—if he was not so learned and accurate a theorist as Mayer,—if he was not to the same degree as Lacaille an exact, expert, scrupulous, industrious, and indefatigable observer and calculator,—if he had not the constancy to attach himself, like Wargentin, to a single object, in order to become the first in a particular department,—and if, in all these respects, he was only an astronomer of the second rank,—he was the first of all as a professor. No one ever did more to propagate the knowledge and love of astronomy. It was his object to be useful and celebrated; and he succeeded, through his labours, his activity, his credit, and his solicitations: by means of a most extensive correspondence he incessantly laboured for the benefit of science: he even endeavoured to serve it after his death, by founding a medal, which the Academy of Sciences adjudges annually to the astronomer who has made the most interesting observation, or written the most useful memoir." (Delambre, *Astronomie du Moyen Age.*)

Maskelyne, born 1732, died 1811.

Bradley was succeeded in the Greenwich Observatory by Dr Bliss, who died in the course of a few years after his appointment. Dr Bliss was in turn succeeded by Dr Maskelyne, the late astronomer royal, under whose care the observatory maintained the high character which it acquired from the immortal labours of his illustrious predecessors. Dr Maskelyne began his astronomical career in 1761, when he was appointed to observe the transit of Venus at the island of St Helena, and endeavour to verify the existence of a small parallax of the star Sirius, which seemed to be indicated by the observations of Lacaille at the Cape. Unfortunately the state of the weather prevented him from observing the transit; and his observations on Sirius were abandoned in consequence of the discovery of a defect in the zenith sector which he had carried out with him for the purpose of making the observations in question. The main objects of his voyage were thus frustrated; but some indirect advantages resulted from it, which compensated in some measure for the disappointment. The attention of Ramsden was called to the sector, and a better method of constructing these instruments was devised. At St Helena he made several interesting observations on the tides, the variation of the compass, the moon's horary parallaxes, &c. In going out and returning home, he paid particular attention to the different methods of finding the longitude at sea, and practised that which depends on observations of the lunar distances from known stars, taken with a Hadley's sextant, or other reflecting instrument. He also composed a set of rules for the use of the seamen, which he published on his return, first in the *Philosophical Transactions*, and afterwards in the *British Mariner's Guide*. In the year 1765 he was appointed astronomer royal, and soon after recommended to the Board of Longitude the general adoption in the navy of the lunar method of finding the

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longitude, and proposed that tables for facilitating that method should be calculated and published in the *Nautical Almanac*. This recommendation was adopted, and the Nautical Almanac continued to be published under his superintendence during forty-eight successive years. He also published a set of tables requisite to be used with that long-celebrated ephemeris; and by these means contributed to bring nautical astronomy to its present state of precision. Dr Maskelyne was most assiduous in the discharge of his important duties as astronomer royal. On one occasion only did he consent to leave the observatory, viz. when at the request of the Royal Society he proceeded to Scotland for the purpose of determining, by experiments on Schehallien, the deflection of the plumb-line occasioned by the attraction of the mountain. The result of the observations made on this occasion furnished data for the determination of the mean density of the earth, which Dr Hutton, by a laborious process of calculation, found to be about five times greater than that of water. Dr Maskelyne had the credit to procure, at the expense of the Royal Society, the regular publication of his observations, by which he rendered a great service to all the astronomers of Europe. The lunar method of determining the longitude, the Nautical Almanac, the catalogue of 36 stars, and some improvements in the construction of instruments, are the principal benefits for which astronomy is indebted to Dr Maskelyne.

Herschel, born 1738, died 1822.

Sir William Herschel, born in Hanover in 1738, has rendered his name immortal by the discovery of a new planet without the orbit of Saturn, and thereby doubling the ancient boundaries of the solar system. Having settled in England, at Bath, he began to devote his leisure to the construction of telescopes and the polishing of reflecting mirrors. Endowed with equal skill and patience, he soon obtained instruments superior to any that had been known before, by means of which he was led to the most brilliant discoveries that have been made in the heavens since the time of Galileo. Being employed in making a review of the sky with a powerful telescope, he perceived, on the 13th of March 1781, near the feet of Gemini, a star of the fifth magnitude, having a disk perfectly well defined, and differing in appearance from the other stars which afforded the same quantity of light. On observing it with a telescope whose magnifying power was 932, he perceived its diameter was enlarged, while that of the stars underwent no change. These circumstances were sufficient to draw his attention to the star, and nothing more was requisite to enable him speedily to discover that it had a slow motion. He at first supposed it was a comet, and acquainted Dr Maskelyne with the discovery. The circumstance was soon made known at Paris; and it was gradually perceived, that as the distance of the star did not sensibly vary, it was necessary to regard it as a seventh planet. Herschel, in honour of his royal patron, gave it the name of the *Georgium Sidus;* but the mythological appellation of Uranus has prevailed. On the 11th of January 1787 he discovered two satellites revolving round the new planet, and subsequently found that it was accompanied by four others. It was soon noticed that Uranus had been observed by Flamsteed, Mayer, and Lemonnier, who had each supposed it to be one of the fixed stars. Their observations enabled Delambre to correct the elements of the orbit, and calculate tables of its motion. By means of his powerful telescopes Herschel determined the figure and rotation of Saturn, discovered the parallel belts on his surface, and perceived that the ring was double. In 1789 he discovered two new satellites belonging to this planet, and revolving within the ring. From some appearances indicated by the fixed stars, Herschel was led to conclude that the whole solar system is in motion about some distant centre, and that its direction is at present towards the constellation Hercules,—a conclusion which recent investigations have amply verified. His observations on nebulæ and double stars opened up a new field of research, boundless in extent and interesting by reason of the variety of the objects it presents to the attention of the observer. The extraordinary activity with which he pursued his favourite occupations is attested by 67 memoirs communicated from time to time to the Royal Society. A great part of these, however, are filled with speculations of no value to astronomy; and his taste was rather to observe astronomical phenomena than to engage in computations, or the more arduous and essential, though less fascinating, labours through which the science can be really benefited. In the course of the following chapters we shall have frequent occasion to allude to his discoveries, and his ingenious speculations concerning the constitution of the sun and the sidereal heavens.

Delambre, born 1749, died 1822.

Few individuals have contributed so eminently to the perfection of modern astronomy as Delambre, the late perpetual secretary of the Academy of Sciences. The scientific life of this illustrious astronomer did not commence till he had attained his 40th year; but from that time till his death it was occupied by a series of unremitting labours to enlarge the boundaries, and ameliorate the practice and theory of the science. Associated with Mechain, he was employed during the troubles of the revolution in measuring the meridian from Dunkirk to Barcelona,—a labour which was prosecuted with admirable zeal in the face of innumerable difficulties, and even dangers of the most formidable kind. By an immense number of excellent observations he determined the constants which enter into the formulæ deduced from theory by the profound researches of Lagrange and Laplace, and also formed a set of tables much more exact than any that had appeared before them. His *Astronomie Théorique et Pratique*, in three quarto volumes, contains the best rules and methods which have yet been devised for the guidance of the practical astronomer; and his *Histoire*, in six large volumes 4to, gives an account of every successive improvement which has been made in the science, and a full abstract of every work of celebrity which has been written respecting it, since the first rude observations of the Greeks to the end of the last century. It is invaluable to the historian, and will ever remain a proud monument of the profound learning and laborious research of its author.

Piazzi, born 1746, died 1826.

The observatory which was established at Palermo about the year 1790, under the active superintendence of Piazzi, holds a distinguished rank among the similar institutions of Europe. Piazzi, born in 1746, took the habit of the religious order of the *Theatins* at Milan, and finished his noviciate in the convent of St Anthony. Among his preceptors he had the advantage of counting Tiraboschi, Beccaria, Le Sœur, and Jacquier; and from these illustrious masters he speedily acquired a taste for mathematics and astronomy. After filling several professors' chairs in the colleges of the Jesuits at Rome and Ravenna, he was appointed in 1780 professor of the higher mathematics in the academy of Palermo. Here his first care was to reform the general system of education; and, by the alterations which he introduced, he contributed powerfully to dissipate the shades of ignorance, which, under the double influence of the Jesuits and the Inquisition, still lowered over the soil of Sicily. After having rendered this service to literature, he obtained from the prince of Caramanico, viceroy of the island, permission to found an observatory, and undertook a voyage to France and

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England, in order to provide the instruments necessary for the new establishment. Having procured a vertical circle, a transit, and some other instruments from Ramsden, he returned to Palermo and commenced his observations. His first care was to prepare a new catalogue of stars, the exact positions of which he justly considered as the basis of all true astronomy. In prosecuting this object he did not content himself with a single observation, but before he fixed the position of any star, observed it several times successively; and, by this laborious but accurate method, he constructed his first great catalogue of 6748 stars, which was crowned by the Academy of Sciences of France, and received with admiration by the astronomers of all countries. His constant practice of repeating his observations led to another brilliant result, the discovery of an eighth planet. On the 1st of January 1801, Piazzi, searching for the star 87 of the catalogue of Mayer, cursorily observed a small star of the eighth magnitude, between Aries and Taurus. On the following day he remarked that the star had changed its position, and accordingly supposed it to be a comet. He communicated his observations to Oriani, who, seeing that this luminous point had no nebulosity like the comets, and that it had been stationary and retrograded within comparatively small limits like the planets, computed its elements on the hypothesis of a circular orbit. He found that this hypothesis agreed with the observations, and other astronomers soon confirmed its accuracy. He gave the planet the name of *Ceres Ferdinandea*, in honour of Ferdinand, king of Naples, in whose dominions it was discovered, and who proposed to consecrate the event by a gold medal, struck with the effigy of the astronomer; but Piazzi, nobly preferring the interests of science to vain honours which could add nothing to his glory, requested that the money destined for this purpose should be employed in the purchase of an equatorial, which was still wanting to his observatory. In 1814 he published a new catalogue, extended to 7646 stars,—a splendid monument of indefatigable zeal and activity. He made an uninterrupted series of solstitial observations from 1791 to 1816, for the purpose of determining the obliquity of the ecliptic, which, compared with those of Bradley, Mayer, and Lacaille, in 1750, give a diminution of 44″ in a year. Besides these labours, sufficient to occupy a life of ordinary industry, Piazzi composed a number of memoirs for the different societies of which he was a member, and was intrusted by the Neapolitan government with several important commissions respecting the public instruction and the regulation of weights and measures in Sicily. He died in 1826, after having bequeathed his library and all his instruments to the observatory at Palermo, and assigned a liberal annuity to be devoted to the instruction of young men who evince a decided taste for astronomy.

Discovery of the planet Ceres.

Discovery of Pallas, Juno, and Vesta.

The discovery of Ceres led to that of three other little planets, circulating at nearly the same distance from the sun,—a circumstance unique in the construction of the solar system. On account of the smallness of the new planet, and the nebulosity by which it is surrounded, the difficulty of finding it after it had for some time ceased to be observed, was so considerable, that Dr Olbers of Bremen was induced to examine, with particular care, the configurations of all the small stars situated in the vicinity of its path, in order to have the means of detecting it at any time with greater facility. While engaged in making observations for this purpose, he discovered, on the 28th of March 1802, and nearly in the same place where he had before observed Ceres, another planet similar in size and appearance, to which he gave the name of *Pallas*. The extraordinary circumstance of the discovery of two planets having nearly the same mean distance, and performing their revolutions nearly in the same time, led Dr Olbers to imagine that Ceres and Pallas were fragments of a larger planet which had revolved in the same place, and been shattered by some external force or internal convulsion. The immediate consequence of this hypothesis was the probability of the existence of other fragments of the original planet, hitherto undiscovered; and that if such fragments existed, the planes of their orbits would pass through the points in which the orbits of Ceres and Pallas intersect each other. This bold idea acquired some probability from the subsequent discovery of two other planets in the very quarter of the heavens to which Dr Olbers had directed the attention of astronomers. *Juno* was discovered by M. Harding of Lilienthal, on the 2d of September 1804; and *Vesta*, by Dr Olbers himself, on the 29th of March 1807. Diligent observation did not for many years add to their number.

Improvements in optical instruments

Astronomy is a science which borrows the aid of several other sciences, with which its advancement is simultaneous. Instruments capable of appreciating or measuring the exceedingly minute quantities about which the observer now concerns himself, could only be produced in a very advanced state of mechanics. In the accurate graduation of large instruments, our English artists have long maintained an unrivalled superiority. Graham, a celebrated watch-maker, united to great dexterity in the mechanical arts a decided taste for observation; and the extraordinary improvements which he effected in the art of dividing form an era in the history of practical astronomy. The sector used by Bradley, in the observations which led to the discovery of the nutation, was of his construction, and he was also the inventor of the first compensation pendulum. Sisson, who succeeded him, maintained in this department the honour and pre-eminence of England. Bird was originally a weaver in Durham, and first gave proof of his mechanical genius by dividing dials for the watch-makers in a manner far superior to what had been commonly practised. He was employed by Sisson in the division of mathematical instruments, and recommended by that artist to Graham, who instructed him in his methods. He constructed the 8 feet quadrants employed in the Greenwich and Paris observatories, and another of 6 feet for Mayer at the observatory of Göttingen. Ramsden invented a machine for the more accurate division of instruments, on account of which he received a premium from the Board of Longitude. The mural quadrants of this artist were held in high estimation, and the transit instrument, sextant, and refracting micrometer, in passing through his hands, received considerable ameliorations. His astronomical instruments in general were considered the best that could be procured in Europe. Mr Troughton, who in his day stood the foremost of our British opticians, more than rivalled his predecessors. In the hands of this distinguished artist and astronomer, the division of instruments was carried to a degree of precision which at the time seemed incapable of being surpassed; while the great improvements he has introduced into the methods of constructing and mounting large instruments, and his ingenious inventions to elude natural obstacles, and guard against the accidental derangements from which it is impossible altogether to protect them, entitled him to the high place which he held by universal consent among the most eminent philosophers and original mechanicians of the age. The numerous circles and other instruments of his manufacture, whether in the hands of private individuals or deposited in the different public observatories, are considered still as the finest specimens of

Graham. Sisson. Bird. Ramsden. Troughton.

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what art has yet accomplished for the advancement of astronomical science. (See Supplement to Part I. for accounts of Modern Instruments.)

Progress of Physical Astronomy.

Having now endeavoured to give an account of the labours of those astronomers who have principally contributed to make us acquainted with the state of the heavens, and the order and succession of the various phenomena they exhibit, we will conclude this part of the article by briefly adverting to the profound researches of some illustrious mathematicians who have developed the theory of Newton, and raised the fabric of physical astronomy to its present proud elevation.

Problem of the three bodies.

Although the law of gravitation, as proposed by Newton, had from the first been admitted by all the most eminent astronomers of Britain, it was for a long time either opposed or neglected on the Continent. In fact, great improvements were required both in analysis and mechanics before it admitted of other applications than had been made by its great author, or could be regarded as any thing more than a plausible hypothesis. Newton demonstrated, that if two bodies only were projected in space, mutually attracting each other with forces proportional directly to their masses, and inversely to the squares of their distance, they would each accurately describe an ellipse round the common centre of gravity; and the spaces described by the straight line joining that centre and the moving body, would be proportional to the time of description, according to the second law of Kepler. But when it is attempted to apply Newton's law to the case of the solar system, great difficulties immediately present themselves. Any one planet in the system is not only attracted by the sun, but also, though in a greatly smaller degree, by all the other planets, in consequence of which it is compelled to deviate from the elliptic path which it would pursue in virtue of the sun's attraction alone. Now, the calculation of the effects of this disturbing force was the problem which geometers had to resolve. In its most general form it greatly transcends the power of analysis; but there are particular cases of it, and those too the cases presented by nature, in which, by reason of certain limitations in the conditions, it is possible to obtain an approximate solution to any required degree of exactness. For example, the Sun, Moon, and Earth form in a manner a system by themselves, which is very slightly affected by the aggregate attractions of the other planets. In the same way the Sun, Jupiter, and Saturn form another system, in which the motions are very little influenced by the action of any other body. In these two cases, then, the number of bodies to be taken into consideration is only three; and in this restricted form, the problem, celebrated in the history of analysis under the denomination of the *Problem of the Three Bodies*, is susceptible of being treated mathematically. With the hope of ameliorating the lunar tables, and of completing the investigations which Newton had commenced in the *Principia*, three distinguished geometers, Clairaut, D'Alembert, and Euler, about the middle of the last century, undertook, simultaneously, and without the knowledge of each other, the investigation of the problem of the three bodies, and commenced that series of brilliant discoveries which it is the glory of our own times to have seen completed.

Clairaut, born 1713, died 1765.

Clairaut's solution of the problem of the three bodies was presented to the Academy of Sciences in 1747, and was applied to the case of the moon. From this solution he deduced with great facility, not only the inequality of the variation, which Newton had obtained by a more complicated, though at the same time a very ingenious method, but also the evection, the annual equation, and many other inequalities which Newton had not succeeded in connecting with his theory. It happened, however, curiously enough, that in the calculation of one effect of the disturbing force, namely, the progression of the moon's apogee, Clairaut was led into an error which produced a result that threatened to overturn the system of gravitation. The error consisted in the omission of some of the terms of the series expressing the quantity in question, which he wrongly supposed to have only an insensible value; and by reason of this omission, his first approximation gave only half of the observed progressive motion of the apogee. As this result was confirmed by D'Alembert and Euler, who had both fallen into the same error, it seemed to follow, as a necessary consequence, either that the phenomenon depended on some other cause than the disturbing force of the sun, or that the law of gravity was not exactly proportional to the inverse square of the distance. The triumph which this result gave to the Cartesians was not of long duration. Clairaut soon perceived the cause of his error; and by repeating the process, and carrying the approximations farther, he found the computed to agree exactly with the observed progression,—a result which had the effect of dissipating for ever all doubt respecting the law of gravity. The researches of Clairaut were followed by a set of lunar tables, much more correct than any which had been previously computed.

The return of the comet of 1682, which Halley had predicted for the end of 1758, or beginning of 1759, afforded an excellent opportunity for putting to the test both the theory of gravity and the power of the new calculus. Clairaut applied his solution of the problem of the three bodies to the perturbations which this comet sustained from Jupiter and Saturn, and, after calculations of enormous labour, announced to the Academy of Sciences, in November 1758, that the comet would return in the beginning of the following year, and pass through its perihelion about the 15th of April. It returned according to the prediction, but passed its perihelion on the 13th of March. The correction of an error of computation reduced the difference to nineteen days; and if Clairaut had been aware of the existence of the planet Uranus, he might have come still nearer the truth.

Besides these important researches on the system of the world, Clairaut composed an admirable little treatise on the figure of the earth, in which he gave the differential equations, till then unknown, of the equilibrium of fluids, whether homogeneous or heterogeneous, supposing an attractive force, following any law whatever, to exist among the molecules. He applied these equations to the earth; demonstrated that the elliptic figure satisfies the conditions of equilibrium; assigned the ellipticity of the different strata of which the earth may be supposed to be formed, together with the law of gravitation at the exterior surface. He likewise discovered the important theorem which establishes a relation between the oblateness of the terrestrial spheroid and the increase of gravitation towards the poles, on every supposition which can be imagined relative to the interior construction of the earth. By means of this theorem the ellipticity of the spheroid is deduced from observations of the lengths of the seconds pendulum at different points of the earth's surface.

D'Alembert, born 1717, died 1783.

D'Alembert, as has already been mentioned, presented a solution of the problem of the three bodies to the Academy of Sciences at the same time with Clairaut. In the year 1749 he published his treatise on the precession of the equinoxes,—a work remarkable in the history of analysis and mechanics. By means of his newly invented

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calculus of *Partial Differences*, and the discovery of a fertile principle in dynamics, he determined from theory the rate of the precession, which is nearly 50″ in a year. He also determined the nutation of the earth's axis, which had been discovered by Bradley, and assigned the ratio of the axes of the small ellipse which the true pole of the earth describes around its mean place, in the same time in which the nodes of the lunar orbit complete a revolution. The solution of this problem led to the determination of the ratio of the attractive forces of the sun and moon, which D'Alembert found to be that of seven to three very nearly; whence he inferred that the mass of the earth is 70 times greater than that of the moon. He proved likewise that the precession and nutation are the same in every hypothesis concerning the interior constitution of the earth. In 1754 he published the first two volumes of his *Researches on the System of the World*. In this work he applied the formulæ by which he had calculated the motions of the moon to the motions of the planets disturbed by their mutual attraction, and pointed out the simplest method of determining the perturbations of the motions of a planet occasioned by the action of its own satellites. D'Alembert also treated the subject of the figure of the earth in a much more general manner than had been done by Clairaut, who had confined his investigations to the case of a spheroid of revolution. He determined the attraction of a spheroid of small eccentricity, whose surface can be represented by an algebraic equation of any order whatever, and even supposing the spheroid to be composed of strata of different densities.

The works of D'Alembert, which are extremely numerous, abound generally in profound and original views, and contributed greatly to the advancement of the physical and mathematical sciences; but it is to be regretted that they are very frequently deficient in that perspicuity and order so necessary in abstruse speculations, and that the course of his reasoning can be followed with difficulty when he descends into the detail of analytical operations. He had a horror of calculation, and delighted in general considerations and speculations which frequently turned on matters of pure curiosity.

Euler, born 1707, died 1783.

The first memoir of Euler on the planetary perturbations was transmitted to the secretary of the Academy of Sciences in July 1747, some months before Clairaut and D'Alembert had communicated their solutions of the problem of the three bodies, and it carried off the prize which the academy had proposed for the analytical theory of the motions of Jupiter and Saturn. In this memoir Euler gave the differential equations of the elements of the disturbed planet, but suppressed the analysis by which he had been conducted to them. This analysis, however, he subsequently expanded in two memoirs, the first of which appeared in the Berlin Memoirs in 1749, and the second in those of Petersburg in 1750. Of these supplementary memoirs the first is remarkable on several accounts. It contains the first example of a method which has been fruitful of important consequences—namely, that of the variation of the arbitrary constants in differential equations, and the development of the radical quantity which expresses the distance between two planets in a series of angles, multiples of the elongations. The expressions which he gave for the several terms of this series were simple and elegant; and he demonstrated a curious relation subsisting among any three consecutive terms, by means of which all the terms of the series may be calculated from the first two. He was thus enabled to develop the perturbing forces in terms of the sines and cosines of angles increasing with the time, and thereby to surmount a very great analytical difficulty. Notwithstanding, however, the great merit of Euler's memoir, several of the formulæ expressing the secular and periodic inequalities were found to be inaccurate; and in order to procure a correction of these errors, and give greater perfection to so important a theory, the academy again proposed the same subject for the prize of 1752. This prize was also carried off by Euler. In the memoir which he presented on this occasion, he considered simultaneously the motions of Jupiter and Saturn, and determined, in the first instance, the amount of their various inequalities, independently of the consideration of the eccentricities of their orbits. Pushing the approximations farther, and having regard to the inequalities depending on the eccentricities, he arrived at a most important result relative to the periodic nature of the inequalities occasioned by the mutual perturbations of the planets; which laid the foundation of the subsequent discovery by Lagrange and Laplace of the permanent stability of the planetary system. He demonstrated that the eccentricities and places of the aphelia of Jupiter and Saturn are subject to constant variation, confined, however, within certain fixed limits, which it never exceeds; and he computed that the elements of the orbits of the two planets recover their original values after a lapse of about 30,000 years. In the year 1756 the Academy of Sciences crowned a third memoir of Euler on the same subject as the two former, namely, the inequalities of the motions of the planets produced by their reciprocal attractions. This memoir, analytically considered, is also of great value. The method which he followed and illustrated has since been generally adopted in researches of the same nature, and consists in regarding as variable, in consequence of the disturbing forces, the six elements of the elliptic motion, viz. 1*st*, the greater axis of the orbit, which, by the law of Kepler, gives the ratio of the differential of the mean longitude to the element of the time; 2*d*, the epoch of this longitude; 3*d*, the eccentricity of the orbit; 4*th*, the motion of the aphelion; 5*th*, the inclination of the orbit to a given fixed plane; and, 6*th*, the longitude of the node. By considering separately the variations introduced into each of these elements by the disturbing forces, Euler obtained some important results; but even in this memoir his theory was not rendered complete. He did not consider the variation of the epoch; and the expression which he gave for the motion of the aphelion did not include that part of it which depends on the ratio of the eccentricities of the orbits of the disturbed and disturbing planet. Besides, the present memoir, like the two former, contained several errors of computation, which, by leading to results known to be wrong, probably prevented the author himself from being aware of the full value of the ingenious methods of procedure which he had exposed. Euler concluded this important memoir by making an extended application of his formulæ to the orbit of the earth as disturbed by the action of the planets. From some probable suppositions, first employed by Newton, relative to the ratios of the masses of the planets to that of the sun, he determined the variation of the obliquity of the ecliptic at 48″ in a century,—a result which agrees well with observation. By this determination the secular variation of the obliquity of the ecliptic, which had been regarded by Lahire, Lemonnier, D'Alembert, and other eminent astronomers, as uncertain, was placed beyond doubt. The three memoirs which we have mentioned contain the principal part of Euler's labours on the perturbations; but physical astronomy is indebted to him for many other researches. He gave a solution of the problem of the precession of the equinoxes, and made several important steps in the lunar theory, with which he seems to have

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occupied himself before he undertook the investigation of the planetary perturbations. In the year 1772, when entirely blind, he directed his son, Albert Euler, and two illustrious pupils, Krafft and Lexell, in the composition of a work of enormous labour on the same subject, which was undertaken with a view to discover the cause of the moon's acceleration. This work was concluded with a set of lunar tables deduced entirely from theory; but they were found to be far inferior to those of Mayer, and in some respects hardly equal to those of Clairaut.

The labours of Euler form an epoch in the history of the mathematical sciences. From the arithmetic of sines, and the simplest formulæ of trigonometry up to the variation of the arbitrary constants of differential equations, there is hardly an analytical theory which has not received extension or improvement from the creative powers of his great mind. The transactions of the Berlin and Petersburg Academies are filled with his inestimable productions; and if fecundity were not itself one of the attributes of genius, the number of the profound and laborious researches in which he was engaged would appear altogether incredible.

Mayer's lunar tables.

The first theory of Euler formed the basis of the excellent lunar tables which were calculated by Tobias Mayer, and first published in the Memoirs of the Academy of Göttingen in 1753. Mayer was a skilful astronomer, and determined the co-efficients of the arguments of the different lunar inequalities from his own observations. He continued to correct and improve his tables till the time of his death, which happened in 1762, when a copy of them, containing his last corrections, was presented by his widow to the Board of Longitude in London. Bradley ascertained their accuracy by comparing them with a great number of his own observations, and made so favourable a report concerning them, that the Board of Longitude presented the widow of Mayer with a gratuity of L.3000. They were printed along with the author's lunar theory in 1765. Subsequently, the Board of Longitude directed Mason, who had been assistant to Bradley, to revise them, under the superintendence of Dr Maskelyne. Mason compared them with about 1200 of Bradley's observations; he corrected the co-efficients of Mayer, and introduced some new equations which had been indicated by that astronomer, but which he had considered as too uncertain, or of too small a value, to render it necessary to load his tables with them. Mayer's tables, thus corrected, were published in 1784, and for a long time continued to be the most accurate that had appeared.

The solution of the problem of the three bodies by Clairaut, D'Alembert, and Euler, gave rise to many other important works relative to the theory of the moon, into the merits of which, however, our limits will not permit us to enter. Thomas Simpson, Walmesley, Frisi, Lambert, Schulze, and Matthew Stewart, treated the subject with more or less success; but the complete explication of the theory of the lunar and planetary perturbations was reserved for two mathematicians, whose discoveries perfected the theory of gravitation, and explained the last inequalities which remained to be accounted for in the celestial motions,—we mean Lagrange and Laplace.

Lagrange, born 1736, died 1813.

In the year 1764, the Academy of Sciences of Paris, which had so successfully promoted the great efforts that had already been made to perfect the theory of attraction, proposed for the subject of a prize the theory of the libration of the moon. This was considered as an appeal to the genius of Lagrange, whose splendid talents had suddenly shone forth in two profound papers on the theory of sound, inserted among the Memoirs of the Turin Academy, and in which the calculus of variations was first explained and made use of. Lagrange had the honour of carrying off the prize; but although he treated the subject in a manner altogether new, and with extraordinary analytical skill, he did not on this occasion arrive at a complete solution of the problem. In 1766 he obtained another prize for a theory of Jupiter's satellites. In the admirable memoir which Lagrange presented to the academy on this subject, he included in the differential equations of the disturbed motion of a satellite, the attracting force of the sun, as well as of all the other satellites, and thus, in fact, had to consider a problem of six bodies. His analysis of this problem is remarkable, inasmuch as it contained the first general method which was given for determining the variations which the mutual attractions of the satellites produce in the forms and positions of their orbits, and pointed out the route which has since been so successfully followed in the treatment of similar questions.

Discovery of the invariability of the mean distances.

Of all the grand discoveries by which the name of Lagrange has been immortalized, the most remarkable is that of the invariability of the mean distances of the planets from the sun. We have already mentioned that Euler had perceived that the inequalities of Jupiter and Saturn, in consequence of their mutual actions, are ultimately compensated, though after a very long period. In prosecuting this subject, which Euler had left imperfect, Laplace had discovered that, on neglecting the fourth powers in the expressions of the eccentricities and inclinations of the orbits, and the squares of the disturbing masses, the mean motions of the planets, and their mean distances from the sun, are invariable. In a short memoir of 14 pages, which appeared among those of the Berlin Academy for 1776, Lagrange demonstrated generally, and by a very simple and luminous analysis, that whatever powers of the eccentricities and inclinations are included in the calculation of the perturbations, no secular inequality, or term proportional to the time, can possibly enter into the expression of the greater axis of the orbit, or, consequently, into the mean motion connected with it by the third law of Kepler. From this conclusion, which is a necessary consequence of the peculiar conditions of the planetary system, it results that all the changes to which the orbits of the planets are subject in consequence of their reciprocal gravitation, are periodic, and that the system contains within itself no principle of destruction, but is calculated to endure for ever.

In 1780 Lagrange undertook a second time the subject of the moon's libration; and it is to the memoir which he now presented to the Berlin Academy that we must look for the complete and rigorous solution of this difficult problem, which had not been resolved before in a satisfactory manner, either on the footing of analysis or observation. In the same year he obtained the prize of the Academy of Sciences on the subject of the perturbations of comets. In 1781 he published, in the Berlin Memoirs, the first of a series of five papers on the secular and periodic inequalities of the planets, which together formed by far the most important work that had yet appeared on Physical Astronomy since the publication of the *Principia*. This series did not, properly speaking, contain any new discovery; but it embodied and brought into one view all the results and peculiar analytical methods which had appeared in his former memoirs, and contained the germs of all the happy ideas which he afterwards developed in the *Mécanique Analytique*.

On account of the brilliant discoveries and important labours which we have thus briefly noticed, Lagrange must be considered as one of the most successful of those illustrious individuals who have undertaken to perfect the theory of Newton, and pursue the principle of gravi-

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tation to its remotest consequences. But the value of his services to science are not limited to his discoveries in physical astronomy, great and numerous as they were. After Euler, he has contributed more than any other individual to increase the power and extend the applications of the calculus, and thereby to arm future inquirers with an instrument of greater power, by means of which they may push their conquests into new and unexplored fields of discovery.

Laplace, born 1749, died 1827.

With the name of Lagrange is associated that of Laplace, whose rival labours divided the admiration of the scientific world during half a century. Like Newton and Lagrange, Laplace raised himself at an early age to the very highest rank in science. Before completing his 24th year, he had signalized himself by the capital discovery of the invariability of the mean distances of the planets from the sun, on an hypothesis restricted, indeed, but which, as we have already mentioned, was afterwards generalized by Lagrange. About the same time he was admitted into the Academy of Sciences, and thenceforward devoted himself to the development of the laws which regulate the system of the world, and to the composition of a series of memoirs on the most important subjects connected with astronomy and analysis. His researches embraced the whole theory of gravitation; and he had the high honour of perfecting what had been left incomplete by his predecessors.

Discovers the cause of the moon's acceleration.

Among the numerous inequalities which affect the motion of the moon, one still remained which no philosopher as yet had been able to explain. This was the acceleration of the mean lunar motion, which had been first suspected by Dr Halley, from a comparison of the ancient Babylonian observations, recorded by Hipparchus, with those of Albategnius and the moderns. The existence of the acceleration had been confirmed by Dunthorne and Mayer, and its quantity assigned at 10″ in a century, but the cause of it remained doubtful. Lagrange demonstrated that it could not be occasioned by any peculiarity in the form of the earth; Bossut ascribed it to the resistance of the medium in which he supposed the moon to move; and Laplace himself at first explained it on the supposition that gravity is not transmitted from one body to another instantaneously, but successively in the manner of sound or light. Having afterwards remarked, however, in the course of his researches on Jupiter's satellites, that the secular variation of the eccentricity of the orbit of Jupiter occasions a secular variation of the mean motions of the satellites, he hastened to transfer this result to the moon, and had the satisfaction to find that the acceleration observed by astronomers is occasioned by the secular variation of the eccentricity of the terrestrial orbit. This was the last celestial phenomenon which remained to be accounted for on the principle of gravitation.

Inequalities of Jupiter and Saturn.

Another discovery relative to the constitution of the planetary system, which does infinite honour to the sagacity of Laplace, is the cause of the secular inequalities indicated by ancient and modern observations in the mean motions of Jupiter and Saturn. On examining the differential equations of the motions of these planets, Laplace remarked, that as their mean motions are nearly commensurable (five times the mean motion of Saturn being nearly equal to twice that of Jupiter), those terms of which the arguments are five times the mean longitude of Saturn, minus twice that of Jupiter, may become very sensible by integration, although multiplied by the cubes and products of three dimensions of the eccentricities and inclinations of the orbits. The result of a laborious calculation confirmed his conjecture, and showed him that in the mean motion of Saturn there existed a great inequality, amounting at its maximum to 48′ 2″·3, and of which the period is 929 years; and that in the case of Jupiter there exists a corresponding inequality of nearly the same period, of which the maximum value is 19′ 46″, but which is affected by a contrary sign, that is to say, diminishes while the first increases, and *vice versa*. He also perceived that the magnitude of the co-efficients of these inequalities, and the duration of their periods, are not always the same, but participate in the secular variations of the elements of the orbits.

Figure of the earth.

The theory of the figures of the planets, scarcely less interesting than that of their motions, was also greatly advanced by the researches of Laplace. He confirmed the results of Clairaut, Maclaurin, and D'Alembert, relative to the figure of the earth, and treated the question in a much more general way than had been done by those three great mathematicians. From two lunar inequalities depending on the non-sphericity of the earth, he determined the ellipticity of the meridian to be $\frac{1}{306}$ very nearly.

Tides.

Newton, in the *Principia*, explained the cause of the phenomena of the tides, and laid the foundations of a theory which was prosecuted and extended by Daniel Bernoulli, Maclaurin, Euler, and D'Alembert; but as no one of these geometers had taken into account the effects of the rotatory motion of the earth, the subject was in a great measure new when it was taken up by Laplace in 1774. Aided by D'Alembert's recent discovery of the calculus of *Partial Differences*, and by an improved theory of hydrodynamics, he succeeded in obtaining the differential equations of the motion of the fluids which surround the earth, having regard to all the forces by which these motions are produced or modified, and published them in the Memoirs of the Academy in 1775. By a careful examination of these equations, he was led to the curious remark, that the differences between the heights of two consecutive tides about the time of the solstices, as indicated by Newton's theory, are not owing, as Newton and his successors had supposed, to the inertia of the waters of the ocean, but depend on a totally different cause, namely, the law of the depth of the sea, and that it would disappear entirely if the sea were of a uniform and constant depth. He also arrived at the important conclusion, that the fluidity of the sea has no influence on the motions of the terrestrial axis, which are exactly the same as they would be if the sea formed a solid mass with the earth. The same analysis conducted him to the knowledge of the conditions necessary to insure the permanent equilibrium of the waters of the ocean. He found that if the mean density of the earth exceeds that of the sea, the fluid, deranged by any causes whatever from its state of equilibrium, will never depart from that state but by very small quantities. It follows from this, that, since the mean density of the earth is known to be about five times greater than that of the sea, the great changes which have taken place in the relative situation of the waters and dry land must be referred to other causes than the instability of the equilibrium of the ocean.

Precession of the equinoxes.

Closely connected with the problem of the tides is that of the precession of the equinoxes, which also received similar improvements in passing through the hands of Laplace. He demonstrated, as has just been mentioned, that the fluidity of the sea has no influence on the phenomena of precession and nutation. He considered some of the effects of the oblate figure of the earth which had not been attended to by D'Alembert, and showed that the annual variation of the precession causes a corresponding variation in the length of the tropical year, which at present is about 9 or 10 seconds shorter than it was in the time of Hipparchus. He proved that the secular inequa-

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lities of the motions of the earth and moon have no sensible effect in displacing the axis of the earth's rotation; and he determined the nutation of the lunar orbit corresponding to the nutation of the terrestrial equator.

Jupiter's satellites.

Physical astronomy is also indebted to Laplace for a complete theory of the system of Jupiter's satellites, from which Delambre constructed a set of tables which represent the motions of these bodies with all desirable accuracy. And when to these numerous and most important researches we add the mathematical theories of molecular attraction, and the propagation of sound, together with many great improvements in analysis,—and reflect, besides, that he is the author of the *Mecanique Céleste*, the *Système du Monde*, and the *Théorie des Probabilités*,—we shall not hesitate to rank him next to Newton among the greatest benefactors of the mathematical and physical sciences.

By the brilliant discoveries of Laplace, the analytical solution of the great problem of physical astronomy was completed. The principle of gravity, which had been discovered by Newton to confine the moon and the planets to their respective orbits, was shown to occasion every apparent irregularity, however minute, in the motions of the planets and satellites; and those very irregularities which were at first brought forward as objections to the hypothesis have been ultimately found to afford the most triumphant proofs of its accuracy, and have placed the truth of the Newtonian law beyond the reach of all future cavil. Such is the state to which analysis has now attained, that the geometer embraces in his formulæ every circumstance which affects the motions or positions of the different bodies of the planetary system; and the conditions of that system being made known to him at any given instant of time, he can determine its conditions at any other instant in the past or future duration of the world. He ascends to remote ages to compare the results of his theories with the most ancient observations; he passes on to ages yet to come, and predicts changes which the lapse of centuries will hardly be sufficient to render sensible to the observer. But notwithstanding the proud elevation to which the theory of astronomy has been raised, it is still far from having reached the limit beyond which further refinement becomes superfluous. The masses of the planets, and some other elements, remain to be determined with still greater precision, by a diligent comparison of the analytical formulæ with good observations; and the labours of the geometer may still be beneficially employed in giving greater simplicity to the calculus, or in extending its power over subjects which have hitherto eluded its grasp. The recent discovery of several periodic comets completing their revolutions in comparatively short intervals of time, opens up an interesting field for speculation and research, and will doubtless be the means of throwing light over some curious and as yet very obscure, points, respecting the appearances, motions, and physical constitution of those strange bodies.

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In the other departments of the science, also, numerous questions still remain to be discussed, the solution of which will occupy and reward the future labours of the astronomer, and in which much progress has been made during the present century, by means of the powerful instruments now employed at the great observatories of every civilized country, and the improved methods of analysis brought to bear upon the results of observation. The curious phenomena of double and multiple stars, some of which appear to form connected systems of bodies revolving about one another, or a common centre of motion,—the variable stars,—the proper motions of the stars,—the translation of the solar system in space,—the progressive condensation of nebulæ,—are subjects still in a great measure new; for it is only of late years that observers have begun to direct the requisite attention towards them, or indeed have been in possession of instruments of sufficient power and delicacy to observe and measure the minute changes which take place beyond the boundaries of our own system. (T. G.)

Supplement to Part I.—1853.

The discoveries in astronomy during the present century have been so brilliant and numerous, and the progress in every department is so rapid, and involves so many details, that we should despair of adequately representing even the outlines of the leading features in such a way as to benefit the reader within the compass of the few pages which can be allotted to the extension of the history which has already been given. We propose, instead of attempting this, to give as briefly as possible an account of the journals, institutions, and observatories which have been chiefly instrumental in producing this rapid progress of the science, and especially to draw the attention of the English student to the works of those great German astronomers, with which he must make himself conversant if he would ever desire to understand the nature of the advances which have been made, and which are absolutely indispensable if he hope to add anything to the fabric which has been erected. The supplement thus given will familiarize the reader with the sources of the various discoveries and investigations which he will meet with in the subsequent parts of the article; and there is scarcely a subject of importance in any department of astronomy which will not receive some elucidation.

Account of Serial Works or Journals, Institutions, and Observatories which have chiefly contributed to the improvement of Astronomy in the nineteenth century.

The history of astronomy has been given with sufficient detail to the beginning of the present century; and, in conformity with the plan already indicated, we propose to exhibit the sources of its rapid advancement since that time, by giving short notices of the principal publications and institutions which have mainly contributed to its progress.

Of the serial works in question, the first to be mentioned is Zach's *Monatliche Correspondenz*, which, commencing with the year 1800, was, till 1813, the leading astronomical journal in Europe. The basis of this work was one conducted previously by Zach, entitled *Allgemeine Geographische Ephemeriden.* This work was devoted chiefly to geographical researches; but Zach was induced to alter his plan, and to commence, on a more extended scale, the celebrated *Correspondenz*, or, as it was entitled by its able editor, *Monatliche Correspondenz zur Beförderung der Erd und Himmel's Kunde.* Soon after its commencement (that is at the beginning of 1801), Piazzi discovered the planet Ceres, the complete history of which discovery, as well as of the discoveries of Juno, Pallas, and Vesta, must be looked for in its pages.

At the end of 1813 this journal was discontinued, having been really conducted from the year 1807 by Lindenau, though Zach was still the responsible editor. Its abrupt termination was due to the French war, in which Lindenau felt himself called upon to take part on the staff of the Duke of Weimar. This war produced a suspension of many of the literary and scientific works of Germany; and it was not till the beginning of 1816 that a new journal was commenced, under Lindenau's direction, bearing the title of *Zeitschrift für Astronomie und verwandte Wissenschaften.* This work, in which Lindenau was assisted by Bohnenberger, differed from its predecessor chiefly in being of a more strictly astronomical character, each number consisting of articles comprehended under one or another of the three divisions, Original Treatises on Astronomical Subjects, Critical Notices of Astronomical Works, and Correspondence.

One of the most valuable portions of this work, which was

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not carried on beyond the year 1818, is the elaborate introduction by Lindenau. It contains a long historical summary of the progress of astronomy during the period of suspension of Zach's *Correspondenz* from 1813 to 1816, thus supplying a gap in the continuous history of the astronomy of the present century.

Amongst the most remarkable of the contributions to the *Zeitschrift*, we may mention the following:—

In vol. i., a paper by Gauss on the *Theory of Certainty in Observations;* also two or three papers by Bohnenberger on the *Precessional Motion of Stars for long Intervals of Time;* and a complete list of the works of Lagrange.

In vol. ii., amongst other interesting papers and letters, an essay by Littrow, *On the Correction to the Mean Refraction due to the Thermometer; A Catalogue of the Arabic Names of the Stars*, by Zach; *Observations* by Bessel, *especially of Right Ascension, for the Determination of the Parallax of* 61 *Cygni; A History of the Greenwich Observatory* by Lindenau; and an *Investigation of the Orbit of the Comet of Pons.*

In vol. iii., a paper by Zach, *On Tobias Mayer's Observations of Uranus;* and one by Littrow, *On the Correction of the Solar Tables.*

In vol. iv., Westphal *On the Periods of Variable Stars;* Plana *On the Changes in the Places of the Fixed Stars, produced by the Secular Motion of the Plane of the Ecliptic;* A letter from Struve *On the Commencement of his Operations at the Observatory at Dorpat.*

In vol. vi., the most important article is by Encke, *On the most probable Orbit of the Comet of* 1680. Other works worthy of notice are,—*On the Accurate Computation of Nutation and Aberration*, by Bessel. *On the General Formulæ for Computation of the Corrections of Six Elements, according to the Method of Least Squares*, by Plana.

The *Zeitschrift* was brought suddenly to a conclusion with the sixth volume, at the end of the year 1818.

The epoch of this journal was one of very great importance to astronomy. Old instruments and old methods were being superseded by new ones. Telescopes of greater power were mounted equatorially in several observatories; and meridian instruments of improved construction were erected. At Greenwich, Troughton's mural circle and transit instrument had been erected, and a series of excellent observations had been begun under Pond's direction. On the continent, Reichenbach's meridian circles were being introduced into every observatory; and the first series of the Königsberg observations, made by Bessel with an instrument of this class, had been published.

But above all, the incomparable *Fundamenta Astronomiæ* of Bessel was published at this time, giving the accurate results of Bradley's star observations, and new values of every element necessary for their reduction, by investigations based on the observations themselves.

The *Tabulæ Regiomontanæ*, or synopsis of all the fundamental quantities needed by the astronomer, which is still indeed an indispensable text book, was published by Bessel in 1830.

Another serial work which must be mentioned, is Zach's *Correspondance Astronomique, Geographique, Hydrographique, et Statisque*, of which the first letter is dated June 1818. This was published in the French language, and was issued from Genoa where Zach was residing. The series terminated with the thirteenth volume in 1825.

In connection with Zach's journals, it may be mentioned, that a complete index to the *Monatliche Correspondenz* was compiled recently by Dr Galle, and published in 1848, preceded by a short memoir of the Baron de Zach.

The journal which succeeded the *Zeitschrift*, was the celebrated *Astronomische Nachrichten*, which is continued at the present time with unremitted utility. It was commenced in 1821 at Altona, under the editorship of Professor Schumacher. The abilities and untiring zeal of its editor, who continued his services till the time of his death in 1850, were mainly instrumental in raising the *Nachrichten* to the high rank which it possesses.

For a biographical account of Schumacher, the reader may consult the eleventh volume of the *Notices of the Royal Astronomical Society.* It will suffice here to mention his principal works. They are, 1. A Collection of Astronomical Tables; 2. Ephemerides of the bright planets from 1820 to 1829, and of the distances of the bright planets from the moon, from 1822 to 1831, inclusive; 3. His Astronomical *Jahrbuch*, from 1836 to 1844, which, in addition to a variety of useful tables, contains numerous popular scientific views and summaries by the greatest geometers of the continent.

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In 1829, the Royal Astronomical Society of London awarded to Schumacher their gold medal for the *Nachrichten;* and, in illustration of the acknowledged character of the work, we quote the following extract from the eulogium pronounced by Sir J. Herschel on that occasion:—" Amongst those numerous and talented individuals throughout the continent and in England, who are attached to astronomy professionally, or from love to the science, the *Astronomische Nachrichten* of Professor Schumacher establishes a point of concourse—a complete bond of reunion. We have there a theatre of discussion of whatever is most new and refined in the theory and practice of astronomy; the utmost delicacies of computation and scrupulous investigation of instrumental errors are given by those most competent to reply and judge of them. To its pages, observations of every kind find their way, especially those which depend for their utility on corresponding observations, or which lose their interest or importance by long suppression. Not a comet appears, but *there* we find its elements handed in from all quarters with wondrous rapidity. Occultations, moon-culminating observations, computations of longitudes and latitudes, disquisitions on practical points, descriptions, advertisements, and prices of instruments,—in a word, everything which can awaken and keep alive attention to the science,—everything that can facilitate the contact of mind with mind. . . . . . The *Astronomische Nachrichten*, in fact, contains the history of astronomical science for the last thirty years; it is the necessary complement and commentary of almost every astronomical publication of value, and is the complete repertory of modern theory and practice, not of Europe, but of the civilized world."

This excellent serial still flourishes under the able editorship of Dr Petersen, and continues to be the great medium of communication for astronomers.

A serial work of the same character as the *Nachrichten*, and performing similar services for the science of astronomy in America, has lately appeared under the editorship of Mr B. A. Gould of Cambridge University, Massachusetts. The first volume was completed in April 1851, and the work has gone on uninterruptedly to the present time.

In proceeding to give some account of the principal ephemerides, we shall confine ourselves chiefly to the French *Connaissance des Temps;* the English *Nautical Almanac;* the Berlin *Jahrbuch;* the *Effemeridi di Milano;* and the *American Ephemeris and Nautical Almanac*, of which the first volume for 1855 has recently been published.

The series of the *Connaissance des Temps* commenced in the seventeenth century, under the superintendence of Picard. Lalande in the following century introduced great changes and improvements, and the work remains substantially as he left it. In both the ancient and the modern volumes, the places of the planets are given only approximately at intervals of several days, though in the modern volumes the daily places of the sun and moon, and other solar and lunar elements, are given with more detail and precision, and provision is made for the determination of the longitude at sea by a copious table of lunar distances for every three hours for the bright stars and the planets. The places are given of a copious catalogue of fixed stars, and particular attention has been paid to render the work useful for maritime purposes. It has always been the vehicle for the publication of some of the most valuable papers of the French astronomers; and in particular we may mention, that it contains the whole of Leverrier's admirable discussions leading to the discovery of the planet Neptune. For many years it was published under the direction of the Academy of Sciences; but was afterwards placed under the direction of the *Bureau des Longitudes.* The modern volumes contain an excellent list of geographical latitudes and longitudes, well determined.

The English *Nautical Almanac* dates from 1767, for which year the first volume was issued in 1766. It was undertaken in connection with the parliamentary commission for the " Discovery of the Longitude at Sea." Dr Maskelyne, the Astronomer-Royal, conducted it for many years. It was afterwards succes-

sively under the direction of the celebrated Dr Thomas Young, secretary to the Board of Longitude, and the Astronomer-Royal, Mr Pond.

About the year 1830, however, the construction of the *Almanac* was found to be defective, and reference was made by the Lords Commissioners of the Admiralty to the Royal Astronomical Society, requesting that body to consider what improvements it would be desirable or necessary to make in the work. A committee was consequently appointed by the society, including every eminent astronomer in the British Isles, together with Professor Struve of Dorpat, to report upon the subject; and in consequence of their recommendations, the work was brought to its present excellent form. One of the greatest changes in principle made in the *Almanac* was its adaptation to the wants of the theoretical and practical, as well as of the nautical astronomer, to which last it was formerly almost exclusively devoted. This scheme introduced a great deal of additional computation of the accurate places of the sun, moon, and planets for every day of the year; the introduction of mean time instead of apparent; the supplying of the constants for the corrections of the mean places of the stars; and finally, a more extensive list of fundamental or well-observed stars, with their mean places deduced with scrupulous accuracy for every year, and with the elements of their reduction. In addition, the times of all the phenomena of Jupiter's satellites are given; a list of moon-culminating stars, and of all stars down to the sixth magnitude which could be occulted by the moon, together with the elements for facilitating the computations of the occultations; and lastly, a list of remarkable phenomena likely to be useful. Every possible information with regard to the places of the large planets, and of the four small planets first discovered, is given, and complete elements for every solar and every lunar eclipse during the year; supplying, in fact, every reasonable want of the general as well as of the nautical astronomer. One important addition to this work is the construction of ephemerides of the planets calculated for the meridian of Greenwich. By this means the observed and the tabular places of these bodies can be immediately compared, and a very easy reduction renders these places almost equally applicable for other observatories not differing greatly in longitude, including all in the British Isles, and several of the continental observatories. The *Nautical Almanac* is so conducted that the volume is always published about three years in advance of the current year, and its price has recently been reduced from five shillings to half that sum.

The first volume of the Berlin *Jahrbuch* was published in 1774 for the year 1776. Its object was twofold, viz., to supply the want of such a work in which Germany had been for some time singular, and "to obtain a repertory for all observations, information, remarks, and treatises connected with astronomical science." From its commencement the *Jahrbuch* was published under the inspection and sanction of the Royal Academy of Sciences at Berlin. The volumes from 1776 to 1783 inclusive, bear on their title-page the name of no responsible superintendent; but the volume for 1784, and those that followed it for a long period, were under the immediate editorship of Bode, and after he relinquished the office, it was put into the hands of Encke, its present superintendent. It has always been famed for the valuable collections of observations and astronomical papers contained in its second part, which forms one of the great storehouses of astronomical data from its establishment to the present time. Its contents are particularly valuable in this respect for the period before the establishment of the *Monatliche Correspondenz*, and it is here that the astronomer must look for the records of his science in the last century.

Almost all the articles in the second part of the first volume are by Lambert, and though this and several succeeding volumes are anonymous, yet it would appear that they were under his management. At the present time it is one of the most useful publications of its class, and is the only one which provides original ephemerides for the recently discovered small planets. Those given in the supplements to the *Nautical Almanac* are taken from the *Jahrbuch*, only adapted to the meridian of Greenwich.

The Milan Ephemeris (*Effemeridi di Milano*) is a useful publication commencing with the year 1800. The modern volumes are sometimes found useful from their supplying some elements of the planetary motions which are wanting in other ephemerides. It contains many valuable observations and papers of the Italian astronomers. Other ephemerides are those of Bologna, Coimbra, and Cadiz; but these require no particular mention.

Very recently an American *Ephemeris and Nautical Almanac* has appeared, which promises to be of great service. It is printed in a large octavo volume, and is published under the authority of the Secretary of the Navy. It is at present under the superintendence of Lieutenant C. H. Davis, U.S.N., the theoretical part being placed under the special direction of Professor Peirce of Harvard College, Cambridge.

This work does not copy implicitly any existing nautical almanac, but, retaining what is best in our own and others, modifies the arrangement in a way which promises to be more generally convenient. One great peculiarity in this work is the separation between the part designed exclusively for the purpose of navigation, and that which is generally useful for the theoretical or practical astronomer. In the second part the places of the stars and the planets are referred to the meridian of Washington, and in the computations, the best elements at present known are scrupulously employed. Thus, for the star corrections, Peters's constants of precession, nutation, &c., have been adapted to Bessel's formulæ; and with regard to the lunar computations, the elements are based on Plana's theory, but include Hansen's inequalities and secular changes of the mean motion and the perigee; and Airy's corrections of the elements derived from the reduction of the ancient Greenwich observations. For the planetary computations, the latest corrections of the elements of each planet have been employed. For Mercury, Leverrier's theory has been used (*Conn. des Temps* for 1848); for Venus and Mars, Mr H. Breen's corrections have been applied to Lindenau's elements (*Memoirs of Royal Astronomical Society*, vols. xviii. and xx.); for Jupiter and Saturn, Bouvard's tables have been used with some changes, and Bessel's value of the mass of Jupiter is employed; for Uranus the elliptic elements of Bouvard are used as the basis, with Leverrier's corrections and perturbations caused by Jupiter and Saturn (*Conn. des Temps* for 1849), and with Peirce's corrections and perturbations arising from the action of Neptune; finally, for Neptune, Peirce's theory and Walker's orbit have been used in the construction of the ephemeris.

Another very useful work is the French *Annuaire*, which contains some valuable articles by Arago, and the *Annuaire de Bruxelles* which, since 1835, has been published yearly under the superintendence of M. Quetelet, director of the observatory of that city.

Finally, we must make mention of the *Comptes Rendus* of the French Institute, which furnishes abstracts of all papers read at the meetings of that body, and contains very many valuable articles by the best French astronomers. This series is, however, too generally known to require more than this passing notice.

We will now proceed to give some account of such modern societies and institutions as have most tended to advance the science of astronomy; and it will be sufficient to advert to two of the most prominent of those connected with England, namely, the *Royal Astronomical Society of London*, and the *British Association for the Advancement of Science*.

The Royal Astronomical Society dates its existence from the year 1820. Previously to this time the greater number of papers relating to English astronomical research were presented to the Royal Society, and many valuable articles appeared from time to time in the *Philosophical Transactions*, particularly those of Sir William Herschel. It was evident, however, that astronomy involved so vast a field of research as to require a totally independent organization. The Astronomical Society, accordingly, was founded; and, at its first meeting in 1821, it enrolled amongst its members every astronomer of reputation in England, and, amongst its associates, several of the most distinguished philosophers of the continent. Amongst its officers at this time were Sir William Herschel (president), and Sir John Herschel, Mr Baily, Mr Babbage, and Dr Pearson; and

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amongst its associates were found the names of Arago, Biot, Delambre, Laplace, Bessel, Gauss, Harding, Littrow, Olbers, Schumacher, Zach, and Piazzi—in fact, every continental astronomer of acknowledged reputation.

From the first establishment of the Society, its serial publications were two, namely, the *Memoirs*, published from time to time in quarto volumes, and the *Monthly Notices*. In the former are printed papers, either practical or theoretical, having more than a temporary interest, and declared by a committee appointed for the purpose to be worthy of a permanent record; in the latter are given abstracts of all papers presented to the Society, and a full account of all the proceedings at the monthly meetings. At the present time the *Monthly Notices* take rather a wider range; and omitting such observations as are sure to appear in the *Nachrichten*, they supply abstracts and reviews of all astronomical papers or books whatever, which appear either at home or abroad.

The quarto volumes of the *Memoirs*, now twenty-one in number, are exceedingly rich in the contributions of both English and foreign astronomers. Amongst the most valuable papers contained in them may be mentioned some of the contributions of the late Mr Francis Baily, including his compiled catalogue of stars (commonly called the *Catalogue of the Astronomical Society*); his *Report on the Pendulum Experiments made by Captain Foster;* his edition of the catalogues of Ptolemy, Ulugh Beigh, Tycho Brahe, and Hevelius; and finally, his account of his repetition of the Cavendish experiment for determining the mean density of the earth.

The volumes contain also many valuable papers by Sir John Herschel, Mr Airy, and many other distinguished astronomers, which it would be invidious to particularize.

The *Monthly Notices* communicate to the Society generally every astronomical circumstance of interest; they give the correspondence of its members with foreign associates, and accounts of every class of observations communicated to the Society by its fellows or correspondents; and, in fact, perform all the offices of a monthly journal for the science in relation to the English scientific public.

In the annual report of the council to the Society, a good retrospect is taken of the events of the past year; and from the date of its establishment, its pages contain perhaps the best materials extant for a history of the science, including memoirs and accounts of all eminent astronomers who have died in the interval.

At the end of 1830 the society obtained a royal charter of incorporation, enabling them to amass property, to receive bequests, and to insure its perpetuity; and, generally, to augment its consideration and sphere of usefulness. It has taken ever since the title of the Royal Astronomical Society of London, and has the sovereign for its patron.

Of all the societies for the advancement of separate physical sciences which have branched off from the Royal Society, as the Astronomical Society was one of the first, so it has been probably the most practically useful. Its reputation has been constantly increasing; and the influence of its works, and of the operations set on foot through its agency, extends to every part of Europe and America, and has produced a marked effect in every department of the science.

The British Association for the Advancement of Science has been also very instrumental in assisting the progress of Astronomy. With its general objects and constitution our present subject is not concerned; and we shall confine ourselves to a mention of such astronomical books or works as it has been the means of producing. The Association was indebted for its existence chiefly to the exertions of the *Yorkshire Philosophical Society*, and to the convictions of that body of the utility of organizing the efforts of the various societies for the advancement of science existing in London as well as in the provincial towns of our empire.

The first meeting of the Association was held at York in September 1831; and, as concerns the science under consideration, a report on the state and progress of physical and practical astronomy was requested from Professor Airy for the meeting of the next year to be held at Oxford. Mr Lubbock was also requested to furnish a report "on the means which we possess, or which we want, for forming accurate tables for calculating the time and height of high water at a given place."

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The former of these reports, which is a most valuable synopsis of the progress of astronomy from the beginning of the present century to the date of the report, is printed in the first volume of the Reports of the Association.

The astronomical works of greatest importance, performed by aid of the funds, and under the auspices of the Association, are, 1st, The compiled catalogue of 8377 stars, formed under the direction of Mr Baily, with an elaborate introduction written by that astronomer; 2dly, the catalogue of Lalande, containing more than 40,000 stars, formed by the reduction of the observations of the *Histoire Céleste*; and 3dly, the catalogue derived from Lacaille's *Southern Observations*, containing 9766 stars.

The formation of the above-mentioned catalogues, and the reduction of the ancient observations of Lalande and Lacaille, necessary thereto, are works of that magnitude and importance which only such a society could have undertaken, and which rank amongst the most valuable boons to astronomy in the present century.

We come now to the most important class of institutions tending to promote astronomy, namely, the great *Observatories*, of which almost every country in the civilized world has one or more. Our limits oblige us to confine ourselves chiefly to those observatories which have produced in the present century important changes and advances in the science, merely adverting to the others by way of reference.

Of observatories of the first class are those of Greenwich, Cambridge, Oxford, Edinburgh, and the Cape of Good Hope, in the British dominions; of Dorpat and Pulkowa in Russia; of Berlin and Königsberg in Prussia; and, finally, the observatory of Paris; and of these we shall give short notices.

The *Observatory of Greenwich* is sufficiently well known to prevent any necessity for dwelling upon its early history; and our remarks will be confined to its operations since the accession of the present Astronomer-Royal, Mr Airy, near the end of the year 1835. At that time the instruments consisted mainly of a 10-foot transit instrument, and a 6-foot mural circle, both by Troughton; of a 5-foot equatorially-mounted telescope by Ramsden, and of another small equatorial (since dismounted) by Sisson. There was also a gigantic 25-foot zenith tube by Troughton, which has been since dismounted. The working staff of the establishment consisted, in addition to the Astronomer-Royal and the first assistant (the Rev. R. Main), of five subordinate assistants. Since that time very little alteration has taken place in the staff or organization of the establishment, excepting in the employment of additional computers.

In 1840 magnetical and meteorological observations were commenced in an observatory built for the purpose, of which the superintendence was given to Mr Glaisher, one of the assistants in the astronomical department, and observations have been carried on up to the present time; for the last few years they have been made, however, by a photographical process.

The principal changes and additions to the instruments are the following:—

In 1838 was erected an equatorial instrument, of which the telescope has an object-glass of 7 inches diameter, with a focal length of 8 feet, presented by the Rev. R. Sheepshanks. This instrument has a clockwork movement attached, and many valuable observations have been made with it.

In 1847 was erected a very massive altitude and azimuth instrument, constructed by the Astronomer-Royal on peculiar principles of solidity and strength, for the purpose of making extra-meridional observations of the moon with as great accuracy as those usually made on the meridian, and thus securing generally a far greater number of observations in each lunation, as well as a good supply of observations near the conjunctions, which was totally impracticable before. Every object intended by this instrument has been amply realized. The observations made with it are of equal excellence with those made on the meridian, and they are more than double in number;—in addition, observations have been made occasionally within thirty hours, and frequently within two days, of the time of conjunction on either side.

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In 1850 was erected a large *transit circle*, intended to replace the transit instrument and mural circle then in use. This instrument, which was brought into use early in 1851, occupies very nearly the same position as the mural circle formerly in use, its centre being 6 feet S. of the point corresponding to the centre of that instrument. It is also 20 feet E. of the position occupied by the transit instrument. The focal length of the telescope is 12 feet, and the diameter of the object-glass is 8 inches. In connexion with the instrument are two collimating telescopes of 5 feet focal length, one to the N. and the other to the S. of it. For the determination of the zenith-point, observations are made daily of the coincidence of the horizontal wire with its image reflected in mercury, as well as observations of stars by reflexion. The pivots of the axis are 6 inches in diameter, and the instrument is of very great weight and solidity. It is found that ordinarily as many observations can be made with it by one observer as could be made formerly with the transit instrument and mural circle by the employment of two observers; and that they are of unexceptionable excellence.

We must not here omit to mention the system of galvanic communications now in operation. Wires were laid in the spring of 1852, connecting the observatory with the general system of wires of the South-Eastern Railway Company; and since that time a communication has also been made between the wires of the Electric Telegraph Company crossing Blackheath, and the observatory. It is thus enabled to communicate at pleasure (with the concurrence of the companies above named) with any place to which the wires of these companies extend; and successful experiments have already been made for the determination of the longitudes of the observatories of Cambridge and Edinburgh. From the observatory hourly time-signals are transmitted to the stations of the South-Eastern Railway at London Bridge, Tunbridge, Deal, and Dover. For the transmission of these signals the circuit is closed by means of a clock whose maintaining power is galvanic; and by a combination of the same agency and of electro-magnets fixed near the trigger which drops the Greenwich time-ball at 1 o'clock, the ball is dropped by electro-magnetic power. A ball erected at the office of the Electric Telegraph Company in the Strand is also dropped by the same agency, the wires in connexion with its electro-magnets being included in the circuit. Several sympathetic clocks in the observatory beat in coincidence with the *motor-clock*, especially one of which the dial is exposed to the public; and it is intended that ultimately clocks at London Bridge and other railway stations shall be put in connexion.

To the Greenwich Observatory, and to the untiring labours of its present eminent director, are due some of the most important works of modern astronomy. The ordinary production of each year is a thick 4to volume, averaging from 600 to 700 pages. The star-observations, as far as the year 1847, are incorporated in a catalogue of 2156 stars, named the *Twelve Year Catalogue*. Recently observations have been made of all stars down to the fourth magnitude included in the British Association catalogue, and visible at Greenwich; a copious list has been observed for the determination of clock error, and is now in ordinary use in addition to the list of the *Nautical Almanac;* and finally, a good list of circumpolar stars has been observed for the determination of the azimuthal errors of the transit instrument.

A great many comets have been in former years well observed with the equatorials, as well as a small catalogue of double stars. The bright planets have all been well measured, and, in particular, the ellipticity of the planet Saturn has been determined by means of measures made with a double-image micrometer, in a paper by Mr Main, printed in the eleventh volume of the *Memoirs of the Royal Astronomical Society*.

Besides the ordinary work of the observatory, many great works have been undertaken and completed by the Astronomer-Royal. Of these the most important is the reduction of the ancient lunar and planetary observations made at Greenwich by his predecessors, beginning with Bradley. Both these works are of a most important character; and the former, immediately after its publication, was instrumental in detecting a remarkable inequality of the lunar orbit, depending upon the action of Venus, on the results being put into the hands of M. Hansen. The ancient lunar and planetary observations form three thick quarto volumes.

Another work of considerable importance was the determination, in 1845, of a large arc of parallel on the earth's surface, by means of chronometrical determinations of the longitudes of stations at Kingstown (Dublin), and the island of Valentia on the west coast of Ireland.

The Observatory of Cambridge.—The building was completed in 1824, and the first director of the observatory was Professor Woodhouse. Professor Airy succeeded him in 1828, and continued till the autumn of 1835, when he became Astronomer-Royal. He was succeeded by Professor Challis, the present director.

The observatory was at first furnished only with a 10-foot transit instrument by Dollond. To this was added in 1832 an 8-foot mural circle by Troughton and Simms, and a 5-foot equatorial by Jones. Finally, the Northumberland equatorial (so called from the title of its donor the Duke of Northumberland) was erected under the direction of Mr Airy in 1838. The telescope of this fine instrument is of nearly 20 feet focal length, and the clear aperture of its object-glass is $11\frac{1}{2}$ inches. It is mounted with its telescope in the plane of the polar axis, which is supported above and below by pivots resting in Ys.

At the accession of Professor Airy, he introduced a very important principle, vigorously followed by himself up to the present time, and now imitated in the greater number of British observatories, namely that of thoroughly reducing every observation before its publication. The elements of reduction are uniform throughout; and, these being explicitly stated in the introduction to each volume of observations, it is comparatively easy to compare the results with those of any other set of reduced observations, even if the elements be somewhat different, by making the requisite alterations.

Mr Airy, while at Cambridge, introduced an important alteration in the use of the mural circle, by observing the reflected as well as the direct image of a star at the same transit, and thus determining the zenith point.

He also introduced the practice of observing the planets when at a considerable distance from opposition on either side. By this means errors in the orbits were rendered capable of detection, for which no data existed previously, especially such as depend upon an error in the radius-vector.

The results of Mr Airy's star-observations, made at Cambridge, were afterwards collected by himself, and published in a catalogue of 726 stars, named the *First Cambridge Catalogue*.

The planetary observations were also grouped by him, and the normal results published in various papers of the *Memoirs of the Royal Astronomical Society*.

The activity of the observatory has continued undiminished to the present time; but, on account of the erection of the Northumberland Equatorial, the chief subjects for observation have become necessarily different. This instrument has been employed systematically for several years in observations of double stars, and of the small planets which recent discoveries have rendered so numerous. Our readers will also remember, and we shall have farther occasion to notice in our history of the planet Neptune (*Supplement to Part II.*), the active part taken by Professor Challis in the search for that planet, and the fact that it was twice actually observed by him before Galle's discovery, although it was not recognised till after the discovery.

The Radcliffe Observatory at Oxford.—This observatory was erected about the year 1774. Its directors have been successively Dr Hornsby, Dr Robertson, Professor Rigaud, and Manuel J. Johnson, Esq., the present director. The observations which have given an honourable distinction to this observatory have been made during the directorship of Mr Johnson, and are inferior to none produced at any establishment with an equal amount of observing force, in number, in accuracy, or in punctuality of publication. They are also published in a reduced state, which adds considerably to their value.

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The instruments consist mainly—1*st*, Of a ransit instrument of 8 feet focal length, and 4 inches aperture of object-glass, constructed essentially in 1843 by Simms; 2*dly*, Of a meridian circle of 6 feet in diameter, erected in 1836 by Jones; 3*dly*, Of a fine heliometer erected in 1850, by the Messrs Repsold of Hamburg, the object-glass of which is by Messrs Merz of Munich, and is of $10\frac{1}{2}$ feet focal length and $7\frac{1}{2}$ inches aperture.

Mr Johnson's great work has been, since his accession to the directorship in 1839, the re-observation of the stars in Groombridge's *Circumpolar Catalogue*, and the careful determination of their magnitudes. This, with the aid of only one assistant, he has completed, and is preparing to arrange the collected results in a catalogue.

This work, when completed, will be a great boon to science on many accounts, but especially for the accurate determination of the proper motions of the stars, more than 4000 in number, contained in the catalogue.

Another assistant has recently been added to the establishment, for the working of the heliometer.

Of the observatories in the British dominions, we will next mention that at the *Cape of Good Hope*. This observatory was established by order in council in 1820, at the instigation of the then existing Board of Longitude. The Rev. Fearon Fallows was appointed the astronomer, with a salary of L.600 per annum, and he was to be supplied with an assistant to carry on the observations. He was instructed to make observations of the same kind and in the same manner as those made at Greenwich, so that "the whole might constitute two corresponding series capable of comparison in all their parts."

Mr Fallows arrived at the Cape in August 1821, and after some unavoidable delays, the observatory was erected on a site he had selected between Liesbeck River and Zwart or Salt River. Notwithstanding innumerable disadvantages and annoyances against which he had to struggle, he contrived to observe a catalogue of 273 stars, the reception of which was announced at a meeting of the Board of Longitude in November 1823.

A new clock by Hardy was shipped for him at the end of 1822, and the transit instrument and mural circle intended for the observatory were progressing; but no steps had been taken for the building of the observatory, which was not completed till 1827, and the instruments were not mounted and ready for use till 1829.

The instruments at that time were,—1*st*, A transit instrument by Dollond, of 10 feet focal length, and 5 inches aperture; 2*dly*, a mural circle by Jones, of 6 feet in diameter, which proved a very faulty instrument, and caused most serious annoyance, not only to Mr Fallows, but to other astronomers.

Mr Fallows did not live long after the completion of his observatory, when he might have expected to reap some rewards of his previous labours and anxieties. He died on the 25th July 1831, deeply regretted in all scientific circles in England.

Mr Henderson succeeded Mr Fallows at the Cape, but resigned his appointment in 1833. During his brief directorship, however, he materially advanced the reputation of the observatory. The bright double star α Centauri was found to have a considerable proper motion; and this induced him to make a series of observations for the purpose of detecting its parallax, which he ultimately found to be about one second of space. This result has since been confirmed by his successor, Mr Maclear.

Mr Henderson was succeeded by the present director, Mr Maclear, who had for his assistant, Mr C. Piazzi Smyth, the present Astronomer-Royal of Scotland. The observations of Mr Maclear for 1834 were published in 4to in 1840, but only one additional volume has appeared since. He has, however, been actively employed, and many valuable results have been printed in the *Memoirs of the Royal Astronomical Society*, of which we may mention, in particular, the details relating to the measurement of Lacaille's arc of meridian.

Two more assistants have at different times been added to the staff, and more recently a magnetical and meteorological observatory has been added, provided with one additional assistant.

A good equatorial, with clock movement, of which the telescope is of $8\frac{1}{2}$ feet focal length, and 6·9 inches aperture, was erected in 1849; and a large transit circle similar to that at Greenwich, and intended to supersede the present meridian instruments, is in course of construction.

Mr Maclear is at present engaged in observing approximately, with the mural circle, all the stars of the catalogue of the British Association which are visible at the Cape, and has already cleared up a great many errors and inconsistencies in Lacaille's observations.

The Royal Observatory of Edinburgh.—This observatory is situated on the Calton Hill of Edinburgh. It had its origin in an astronomical institution, whose members built on the Calton Hill a small observatory, and placed it in the charge of the Professor of Astronomy and Natural Philosophy, Dr Wallace. At this time there existed a sinecure Professorship of Practical Astronomy; but, at the death in 1828 of Dr Blair, who had for some time occupied the chair, the government declined to fill up the vacancy immediately. The office remained vacant from 1828 till 1834; when an agreement was made between the government and the members of the Institution, whereby the latter gave up to the university the use of the observatory on the Calton Hill, which the former undertook to convert into a public establishment, by furnishing it with suitable instruments, and making provision for an observer and an assistant. It was then resolved to fill up the office of Professor of Practical Astronomy, and to combine with it the direction and superintendence of the observatory; and this arrangement has continued till the present time, though until lately no attempt was made to form a class of practical astronomy.

Mr Henderson, on resigning his appointment at the Cape, was appointed to the office, and continued to fill it until his death, which took place in 1844. Under his able directorship, and by his unremitting labours, the Edinburgh Observatory immediately took its place amongst the best institutions of the kind. The observations made with the transit instrument and mural circle rivalled those made at Greenwich in accuracy and in number, taking into account its small establishment; while the director illustrated and extended astronomy generally by a long series of papers on various branches of the science, many of which are of great value, and are reckoned amongst the most valuable contributions of the time. He had considered it an indispensable duty to reduce the observations which he had made at the Cape of Good Hope; and at this he worked diligently as long as his life lasted, and his other duties would permit.

It has been already mentioned that he determined the parallax of α Centauri. By comparison of his observations of the moon made at the Cape with those made in Europe, he established the necessity of a considerable augmentation of the moon's parallax; while, by observations of very low stars, he has produced materials for a new set of refraction tables. Finally, he deduced from his observations a catalogue of the declinations of 172 principal stars, chiefly in the southern hemisphere. Indeed, he seems to have done for his epoch in some degree the same thing which was done by the illustrious Bessel; he redetermined and corrected some of the most important astronomical elements, and his papers remain as models of elegance and accuracy to future inquirers.[1]

At the time of Mr Henderson's death he left five published volumes of observations, namely, those from 1834 to 1839, and a sixth nearly ready for publication. His successor, Professor Piazzi Smyth, took upon himself the charge of reducing the observations of the remaining years up to the time of his decease. This task he has accomplished; and the *Edinburgh Observations* now form an uninterrupted series from 1834 to 1844, printed in ten volumes 4to, and inferior to none yet produced in accuracy or utility.

The principal instruments of the observatory consist of a transit instrument by Repsold and Son of Hamburg; a mural circle by Troughton and Simms; and an altitude and azimuth

[1] For a complete catalogue of his works, see the *Monthly Notices of the Royal Astronomical Society*, vol. vi. p. 190.

instrument by the same artist. The transit telescope is of nearly $8\frac{1}{2}$ feet focal length, and $6\frac{1}{4}$ inches aperture. The 6-foot mural circle is similar to those formerly used at Greenwich.

Since the accession of Professor Smyth, a new arrangement has been made with the government. The town authorities have consented to make over the building to the crown, on condition of the latter taking upon itself the sole charge of defraying the expenses of the establishment, and of providing for its adequate and perpetual maintenance. A general repair of the building and the instruments has since been made, and at the same time a board of visitors was appointed, so as to render the management of the observatory in most respects similar to that of Greenwich.

The *Observatory of Paris* was built by order of Louis XIV. during the years 1668 to 1671. It had for its first directors successively the four Cassinis; namely, the celebrated Dominique Cassini, and after him Jacques Cassini, Cæsar Francois Cassini, or Cassini de Thury, and finally Jean Dominique Cassini, or the Comte de Cassini. For the ancient history of this observatory, the reader may refer to Delambre's *Astronomie au dix-huitième siecle*, p. 311; we have space only for a few remarks on its modern condition.

The instruments have consisted for some years chiefly of a transit instrument by Gambey; of a mural circle, completed by Fortin in 1822, and of another since erected by Gambey; and finally of a good equatorial of moderate size by the latter artist.

Several volumes of unreduced observations have recently been published in folio, which give ample evidence of the skill and industry of the observers, but they do not appear to be made on any settled plan, and the introductions defend the principle of publishing them in the unreduced state. Individually, the astronomers of the Paris Observatory have taken a good part in the recent discoveries and rapid progress of the science. Faye, Laugier, and Mauvais have been distinguished by their cometary discoveries, as well as for other valuable works; Leverrier is the famed discoverer of the planet Neptune; and, finally, Villarceau is distinguished for his researches on the orbits of double stars.

For many years the Paris observations were printed in the *Connaissance des Temps*. The observations from 1800 to 1803 are printed in the volumes for 1823, 1824, and 1825. From 1803 to the commencement of 1810, they are printed in the volumes extending from 1808 to 1812.

Afterwards they were printed in two distinct folio volumes, the first of which contains the observations from 1810 to 1819, and the second from 1820 to 1828. Finally, a new series has been published in folio, containing, in ten volumes, the observations from 1837 to 1846.

The *Observatory of Berlin* is of comparatively recent date, but the institution was contemporary with that of the Academy of Sciences, which dates from the commencement of the seventeenth century. Omitting the history of the institution before the erection of the modern building, which is only interesting in connexion with the publication of the *Jahrbuch* under Bode, and which may be found in Encke's introduction to the first volume of his observations, we shall confine ourselves to a short description of the modern observatory.

Encke succeeded Bode about 1822, but it was not till 1828 that, on the representations of Humboldt, measures were taken for the erection of a suitable observatory, of which the foundation-stone was laid in 1832.

The building is situated in the Lindenstrasse, near the north boundary of the city wall, and the instruments are placed in apartments above the ground floor, on solid piers of masonry carried up from the foundation. It contains—

1. A large refracting telescope by Fraunhofer, mounted equatorially, of the same dimensions with that at Dorpat, the mounting being similar to that of the Königsberg heliometer.

2. A $3\frac{1}{2}$-feet meridian circle by Pistor, the telescope of which is of 5 feet focal length, and of $5\frac{1}{4}$ inches aperture.

3. A $3\frac{1}{2}$-feet transit instrument by Dollond, placed in the prime vertical.

4. A heliometer of 42 inches focal length, by Utzschneider and Fraunhofer, mounted equatorially.

There are as usual several smaller instruments, and a magnetical observatory has been added to the establishment.

Three folio volumes of observations, commencing with 1838, have been published.

The importance of this observatory is chiefly due to the labours of Professor Encke. We have already mentioned his researches on the comet of 1680, and he is still more celebrated for those on the comet bearing his name, which have been the means of bringing into evidence the existence of a very thin resisting medium pervading the planetary spaces. Recently he has published a very ingenious method of calculating the disturbances of the small planets. This memoir has been translated by Mr Airy, and is published as an appendix to the *Nautical Almanac* for 1856.

Dr Galle, who was till lately attached to the observatory, has also added to its reputation by the discovery of two comets, and still more by the discovery of the planet Neptune, on the first evening of his search, near the position indicated by Leverrier.

The *Observatory of Königsberg* was finished in 1813, and none has contributed more during the present century to the improvement of every branch of astronomy than this observatory, under the direction of Bessel.

It is situated on the summit of a hill on the N.W. of the city, and at first was but moderately equipped with instruments. In 1820 there was added a good meridian circle by Reichenbach, and with this instrument were made those observations of small stars lying between 45° N. declination and 15° S. declination, known by the name of Bessel's Zones. These observations have been recently reduced (as far as 15° N. declination) by Dr Weisse, and the resulting catalogue is printed in 4to.

In 1829 was erected the celebrated heliometer by Fraunhofer, which is described in the *Memoirs of the Royal Astronomical Society*, vol. xii. The most celebrated work performed with it by Bessel, was the detection of the parallax of the binary star 61 Cygni. It has been since used by Wichmann in the attempt to detect the parallax of the star No. 1830 of Groombridge's catalogue.

In 1841, a new and improved meridian circle, by the Brothers Repsold of Hamburg, was erected, and in the use of it Bessel introduced the practice of obtaining the nadir point by means of observations of the coincidence of the direct and reflected images of the horizontal wire of the telescope.

The fame of this observatory is so intimately connected with that of Bessel, that a full account of the works performed in it would be but a record of part of the life of that great man, and for this we would refer the reader to the *Notices of the Astronomical Society*.

Our limits oblige us to be brief in our accounts of the Russian observatories at Dorpat and Pulkowa, which have both attained the highest possible distinction through the labours of Struve.

The *Observatory of Dorpat* was built about 1811, and in 1813 Struve was appointed to it. For some time its chief instrument was an 8-feet transit instrument; but in 1822 a large meridian circle by Reichenbach was added; and at that time Struve began those researches in sidereal astronomy which have rendered him so famous.

In 1824 was added the great Fraunhofer refractor, of which a particular description, accompanied with plates, is given in Part iv. of this article.

The results of Struve's labours with regard to double stars are contained in a large folio volume, entitled, *Stellarum duplicium et multiplicium mensuræ micrometricæ per magnum Fraunhoferi tubum, annis à 1824 ad 1837 in Speculâ Dorpatensi*, Petropoli, 1837. This volume is accompanied by a smaller work of reference, entitled *Catalogus Novus Stellarum Duplicium*.

Very recently, M. Struve has published another large folio, giving the mean places for 1830 of the stars observed at Dorpat. The title is *Stellarum fixarum imprimis duplicium et multiplicium positiones mediæ pro epocha 1830, deductæ ex observationibus meridianis, annis 1822 ad 1843, in Speculâ Dorpatensi institutis.*

History.

M. Struve was appointed in 1839 to the new observatory to be erected at Pulkowa, and was succeeded by M. Mädler, who has well sustained the reputation of the observatory of Dorpat.

The foundation-stone of the *Observatory of Pulkowa* was laid in 1835; and in the autumn of 1839 this best endowed and most perfectly organized of all European observatories was completed and in working order. We must be content to give only a few details concerning this admirable institution.

The instruments are the following:—

1. A large transit instrument by Ertel, with provision for reversing the position of the eye-piece and object-glass, and with a collimating mark placed on a pier to the S. of the instrument.

2. A large vertical circle by Ertel, in construction similar to an astronomical theodolite. The focal length of the telescope is 77 inches, and the diameter of the object-glass very nearly 6 inches. With this instrument were made M. Peters's observations for determining the parallax of certain stars, of which the results are given in his paper, *Récherches sur la Parallaxe des Etoiles Fixes*, printed in the Transactions of the Petersburg Academy.

3. A meridian circle by Repsold, with all the improvements suggested by M. Struve's experience. The focal length of the telescope is nearly 7 feet, and the aperture of the object-glass 6 inches. "This instrument is designed," says M. Struve, "for the collection of a great mass of observations to serve for the construction of a vast catalogue of stars."

4. A large transit instrument by Repsold, placed in the prime vertical. The telescope is of 7½ feet focal length, and 6½ inches aperture of object-glass. With this instrument M. Struve made his observations for determining the value of the constant of the aberration of light discussed in his paper, *Sur la Coefficient de l'Aberration des Etoiles Fixes*, 1843.

5. The great refracting telescope by Merz and Mahler, of which the focal length is 22½ feet, and the clear aperture of the object-glass 15 inches. It is mounted equatorially according to the usual method applied to foreign telescopes. It has been used with great effect by M. Otto Struve, son of the director, on the system of Saturn and on other objects. A similar telescope has since been erected at the observatory of Harvard College, Cambridge, Massachusetts, which has added to astronomical discovery.

6. A heliometer by Merz and Mahler, of which the focal length is 10 feet, and the aperture of the object-glass is 7½ inches.

These are the grand instruments of the establishment, which is also liberally supplied with smaller instruments of every kind. There is also a very fine library attached to the establishment, of which the foundation is that of Olbers, purchased after his decease.

Connected with the observatory are workshops for making the requisite repairs and alterations in the instruments, and to these are attached mechanists and carpenters superintended by proper officers.

Besides the persons on the ordinary staff of the establishment, several others are ordinarily attached, either for instruction or for the carrying on of special works, or in connexion with geodetical or geographical operations. To give some idea of the extent of this noble institution, M. Struve estimated that in 1844 there were no fewer than 103 persons (including the wives and families of the persons employed) residing within its boundaries.

We are obliged to conclude this short account of a few of the leading observatories of Europe, without mention of many others of very considerable importance in the history of astronomy. We should have been glad to have given some detailed notices of that of Bonn, including the labours of Argelander, and of Hamburgh, including those of Rumker. The observatories of Cambridge and Washington in the United States are also of great importance; as well as the private observatories of Mr Bishop, Mr Lassell, Lord Rosse, and Mr Cooper. The preceding sketch may however suffice to show the great activity that during the present century has pervaded every branch of astronomy, and to guide the student in some measure to the sources of astronomical knowledge relating to the present epoch.

Works on the history of astronomy.

The following works may be consulted on the history of astronomy:—Riccioli, *Almagestum Novum*, Bononiæ, 1653, 2 vols. folio; Sherburn's *Translation of the Astronomicon of Manilius*, London, 1675; Weidler, *Programma de Veteris et Novæ Astronomiæ Discrimine*, Wittembergæ, 1720; Souciet, *Observationes Mathematiques, Astronomiques*, &c., 1729, 2 vols. 4to. The second volume of this work, by Gaubil, contains a history of the Chinese Astronony, with Dissertations. Weidler, *Historia Astronomiæ*, Wittemb. 1741; Idem, *Commentatio de Mechanica Astronomica Medii Ævi*, 1742; Long's *Astronomy*, London, 1742; Costard's *Letter to Martin Folkes concerning the Rise and Progress of Astronomy among the Ancients*, London, 1746; Foulques' *History of Astronomy*, London, 1746; Heathcote, *Historia Astronomiæ*, Cantab. 1747, 8vo; Esteve, *Histoire Générale et Particulière de l'Astronomie*, Paris, 1755, 3 vols. 12mo; Goguet, *Origine des Lois, des Arts, et des Sciences*, various editions; Jablonow, *De Astronomiæ Ortu ac Progressu*, &c., Romæ, 1763, 4to; Bailly, *Histoire de l'Astronomie Ancienne et Moderne*, 1775, 1779, 1782, 4 vols. 4to. This work has been published without the notes and calculations in 2 vols. 8vo, Paris, 1805. Gentil, *Sur l'Astronomie des Indiens*, *Hist. Acad.*, Paris, 1772; Gaubil, *Histoire de l'Astron. Chinoise*, in the *Lettres Edifiantes et Curieuses*, tom. xxvi.; Bailly, *Traité de l'Astr. Indienne*, Paris, 1787, 4to; Playfair's *Remarks on the Astronomy of the Brahmins*, in the *Edinburgh Transactions*, republished in the 3d volume of his *Works*; *Asiatic Researches*, vols. ii., vi., viii.; Adam Smith's *Fragment on the History of Astronomy*; Lalande, *Astronomie*, Paris, 1792, 3 vols. 4to; Idem, *Bibliographie Astronomique, avec l'Histoire de l'Astronomie depuis* 1781 *jusques à* 1802; Vince's *Astronomy*, vol. ii., Cambridge, 1799; Kaestner, *Geschichte der Mathematik*, Göttingen, 1796; Schaubach, *Geschichte der Griechischen Astron. bis auf Eratosthenes*, Göttingen, 1802, 8vo; Montucla, *Histoire des Mathématiques*, Paris, an 7, an 10 (1802), 2d edit. 4 vols. 4to; Laplace, *Exposition du Système du Monde*, and Pond's *Translation* of the same work; Small's *History of the Discoveries of Kepler*, 1803; Bossut, *Histoire Générale des Mathématiques*, Paris, 1810, 2 vols. 8vo; Voiron, *Histoire de l'Astronomie depuis* 1781 *jusques à* 1811, Paris, 1811, 8vo, a continuation of Bailly; Delambre, *Histoire de l'Astronomie Ancienne*, Paris, 1817, 2 vols. 4to; Idem, *Histoire de l'Astronomie du Moyen Age*, 1819, 4to; Idem, *Histoire de l'Astronomie Moderne*, 1821, 2 vols. 4to; Idem, *Histoire de l'Astronomie du xviii. Siècle*, 1827, 4to. These six volumes of Delambre's *Histoire* contain copious extracts of all the principal works which have been published on the subject of astronomy, interspersed with much enlightened criticism; *Geschichte der Astronomie*, von Dr G. A. Jahn, Leipzig, 1844, 2 vols.; Airy's *Report on Astronomy* in *British Association Report* for 1832, vol. i.; Grant's *History of Physical Astronomy*, 1852, 8vo.

(R. M—N.)

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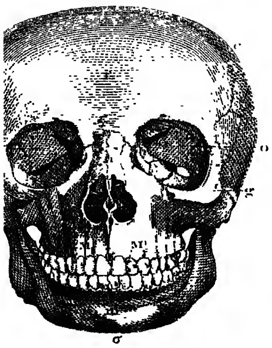

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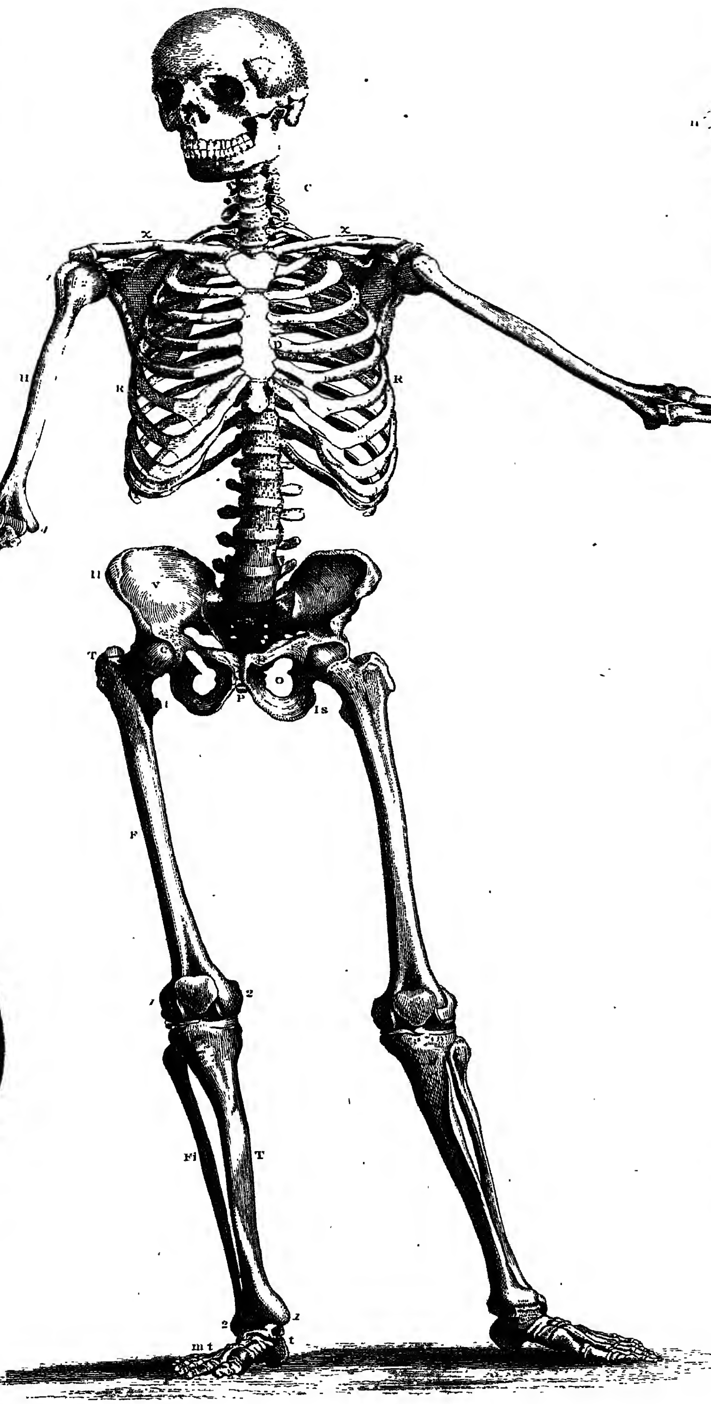

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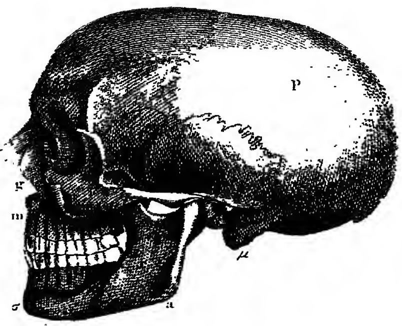

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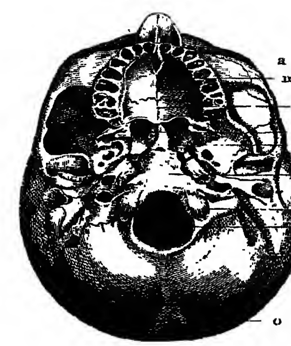

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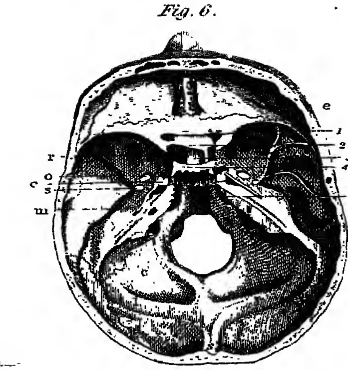

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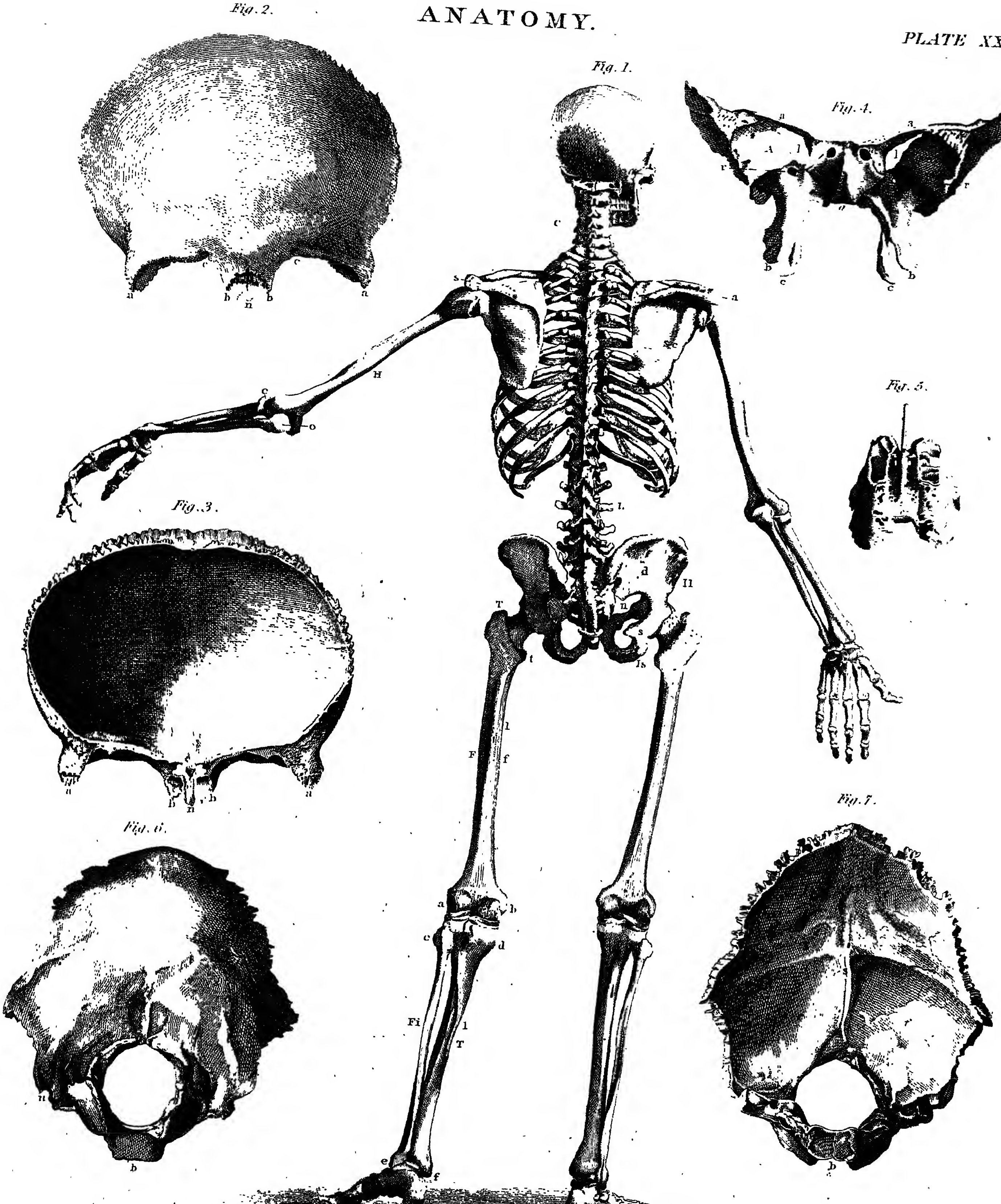
ANATOMY.

PLATE XXV.



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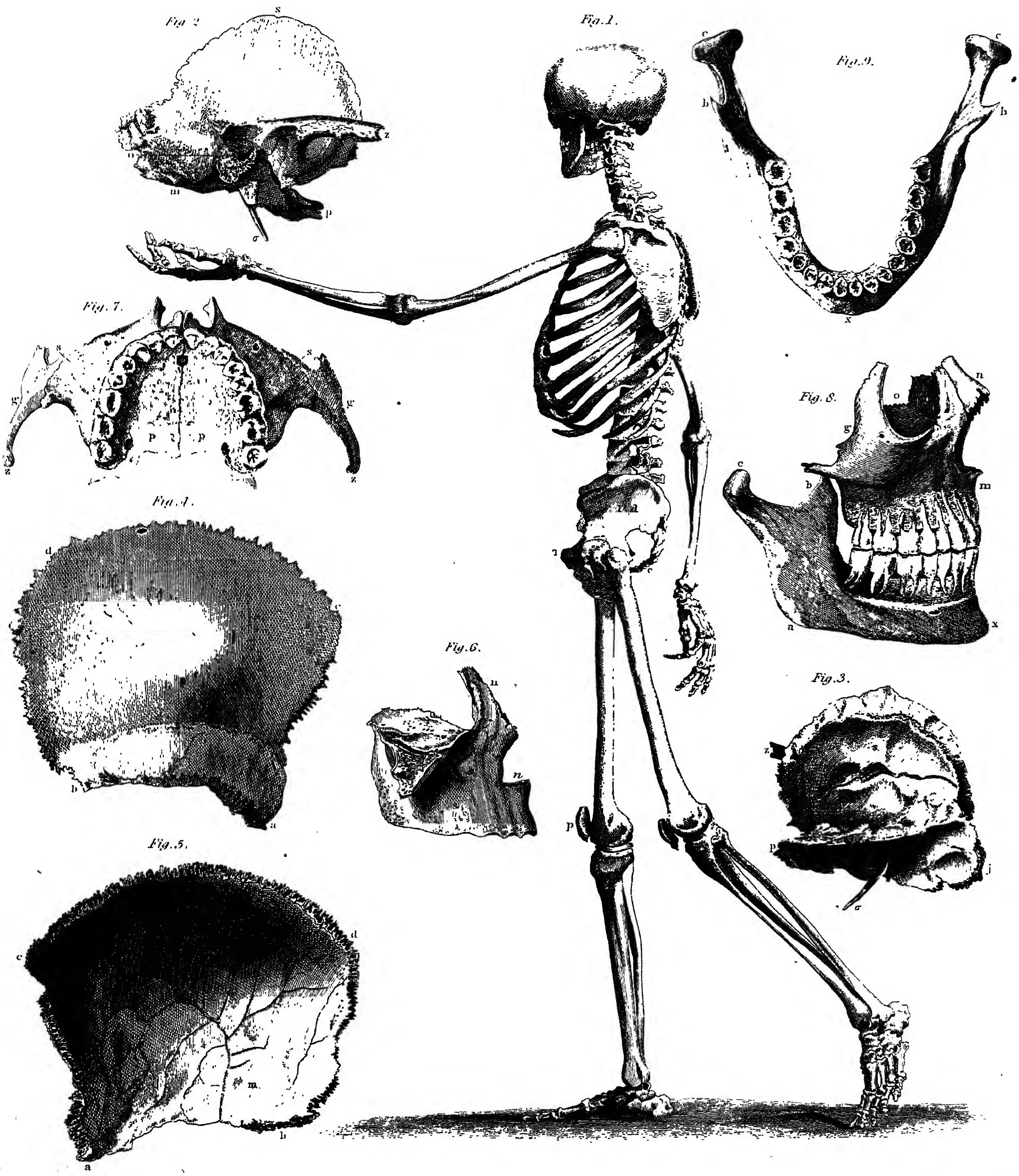

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Fig. 2.

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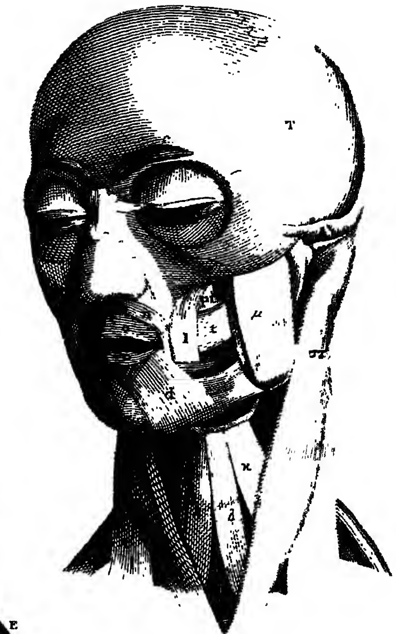

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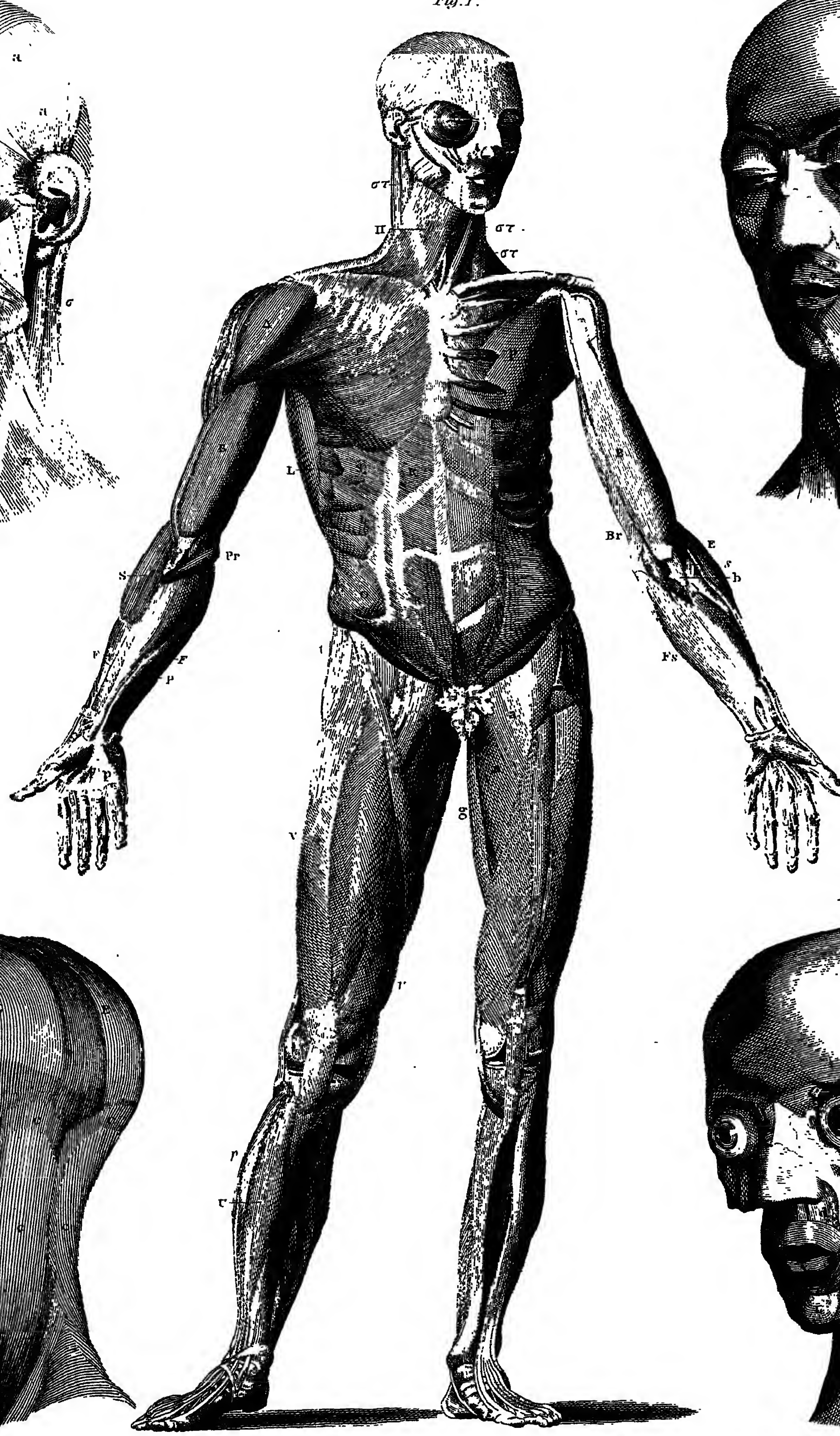

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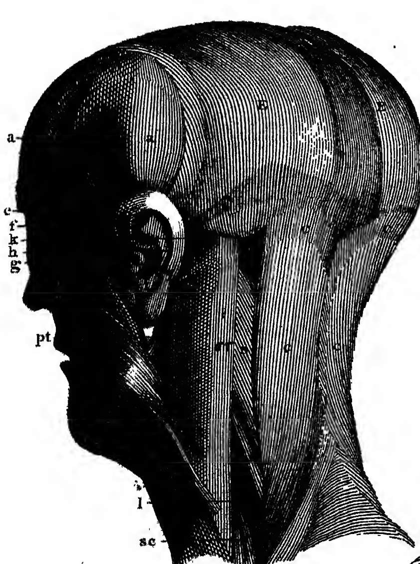

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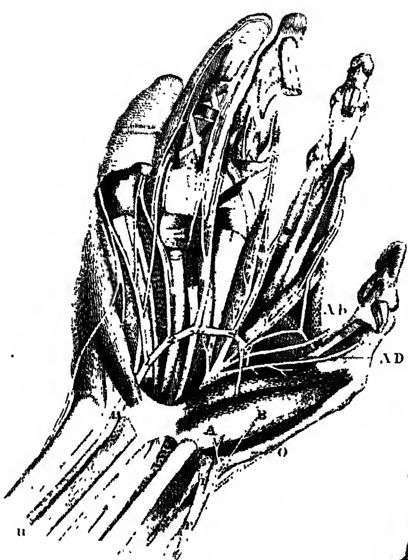
PLATE XXVIII.

Fig. 2.



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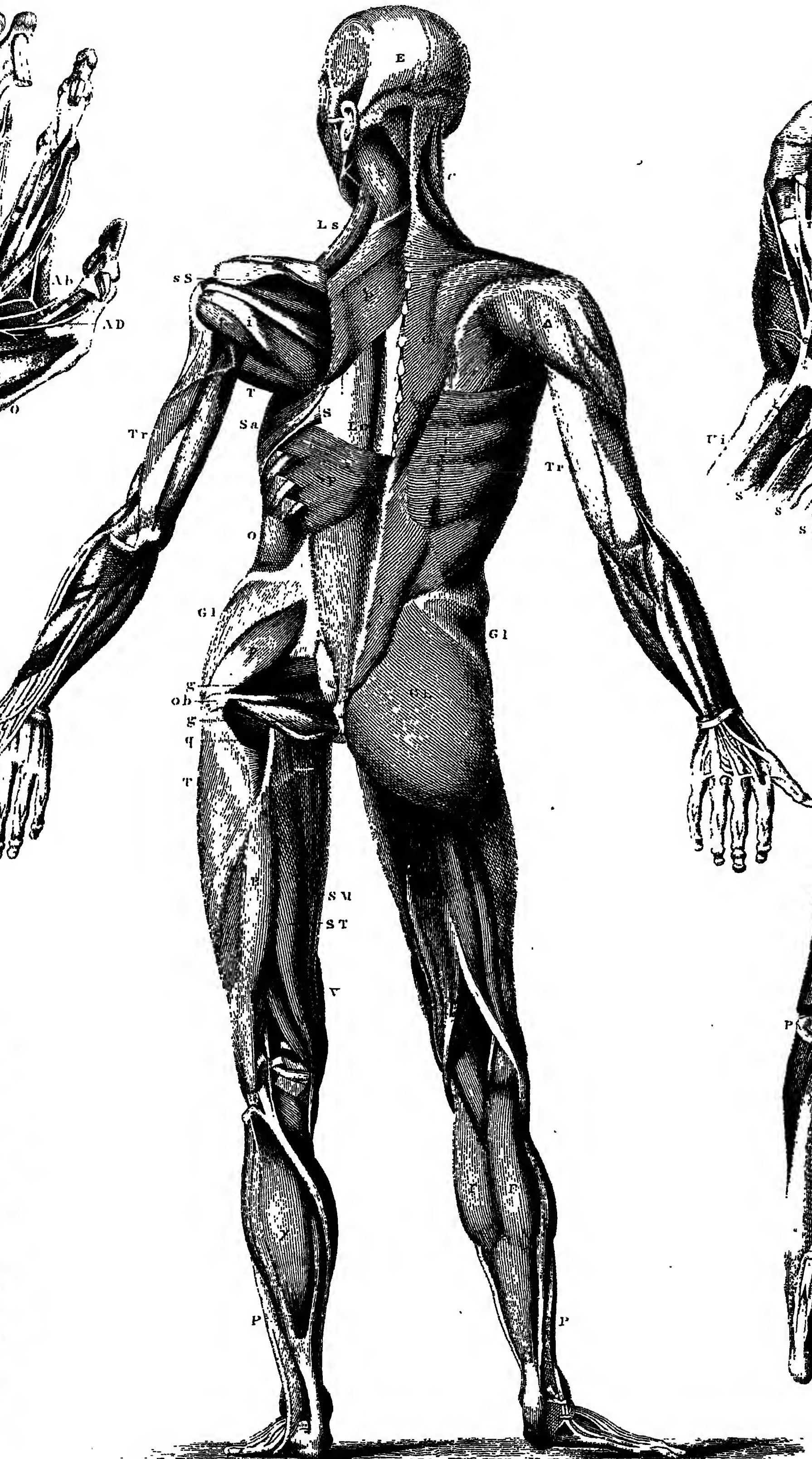

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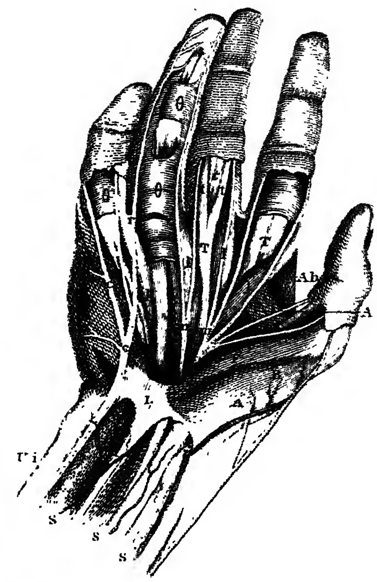

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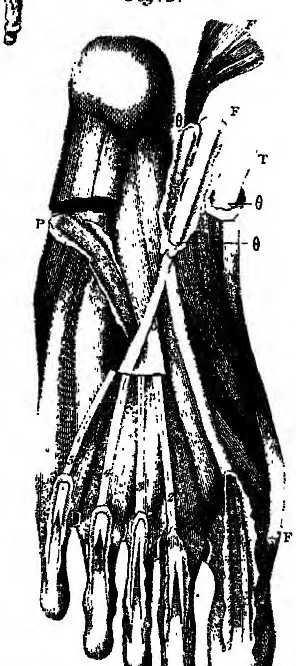

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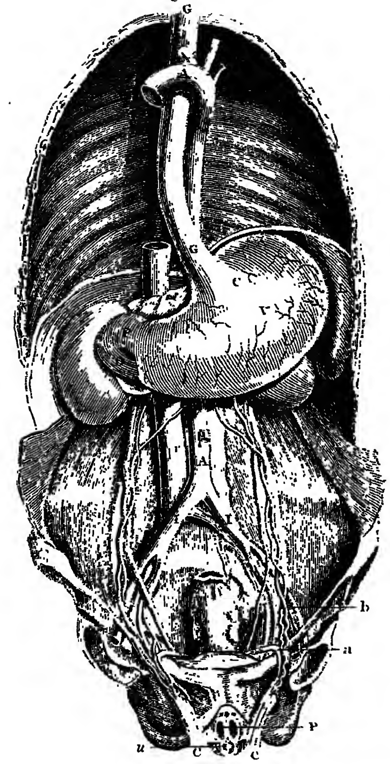

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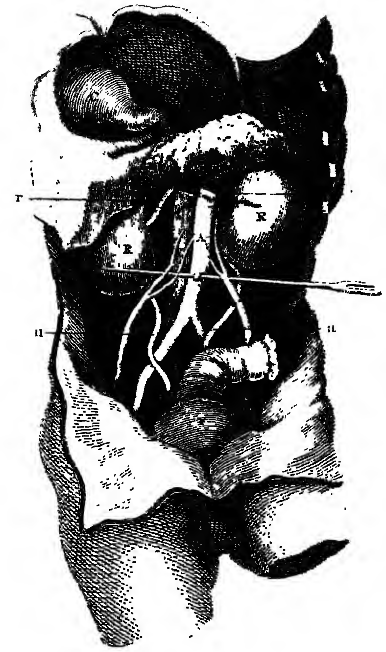

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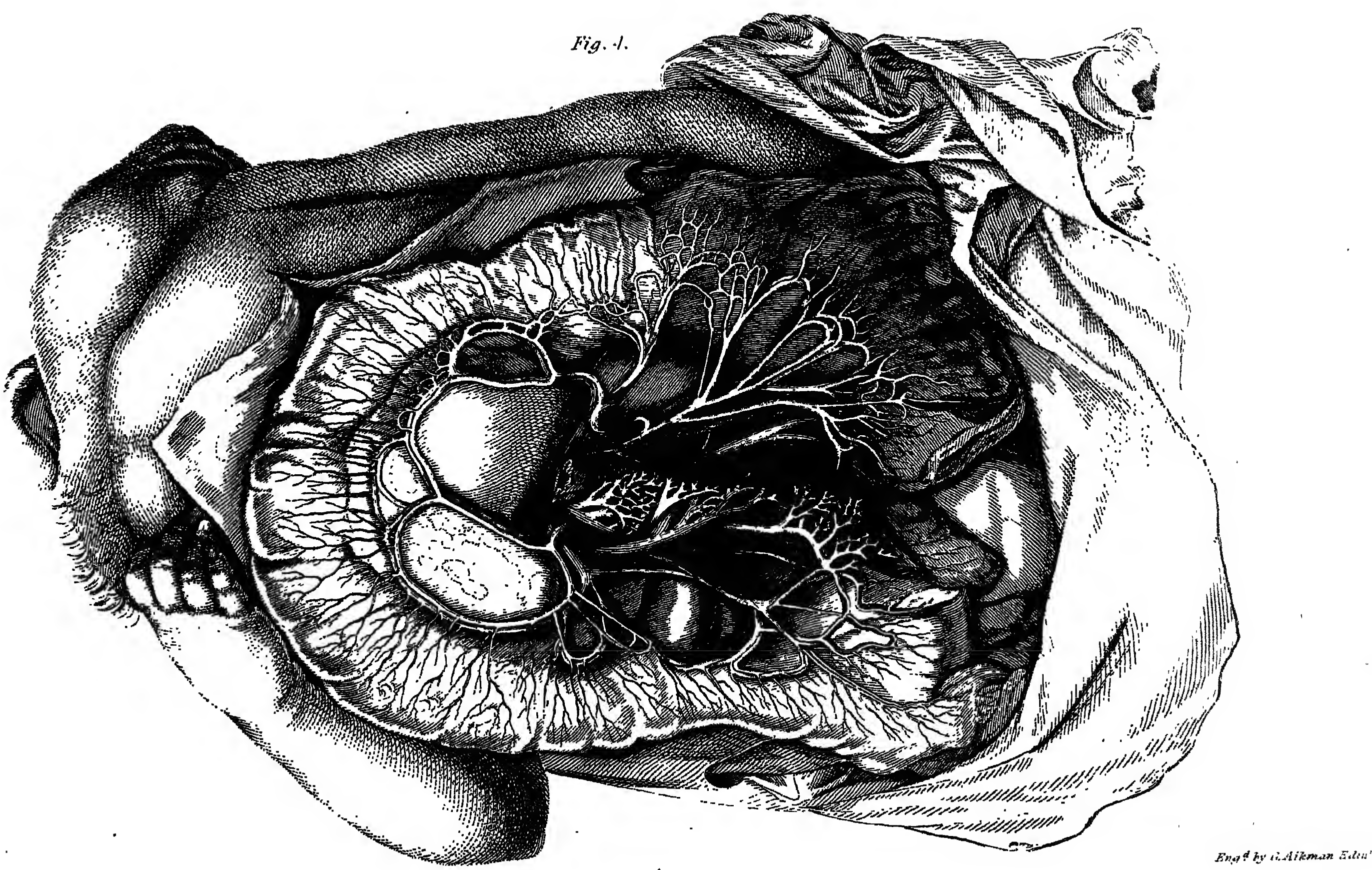

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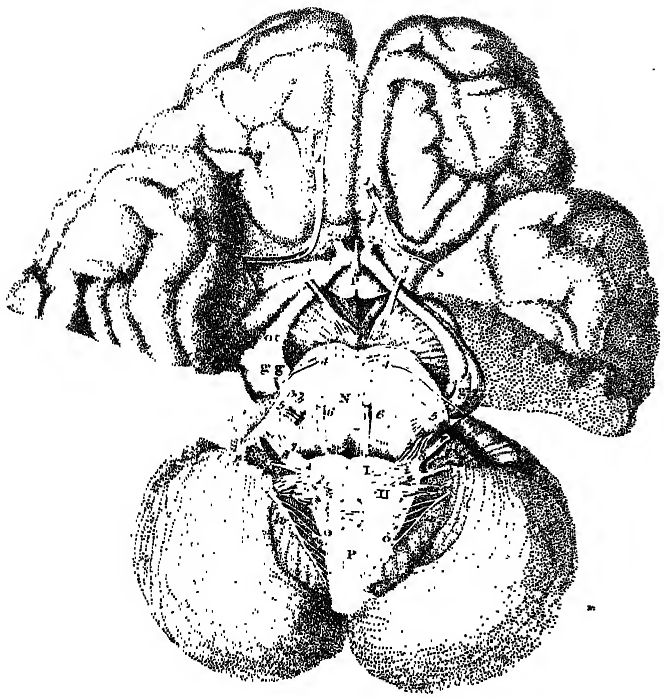
PLATE XXX.

Fig. 1.



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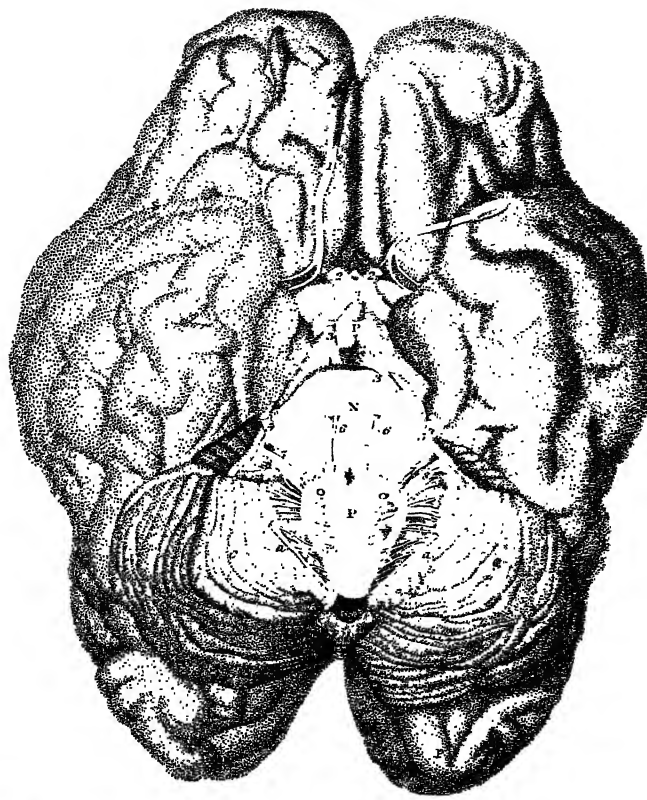

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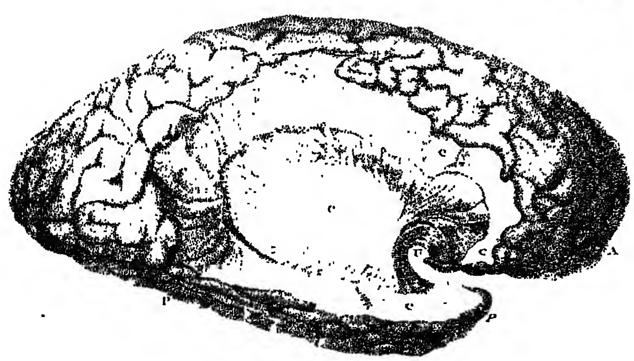

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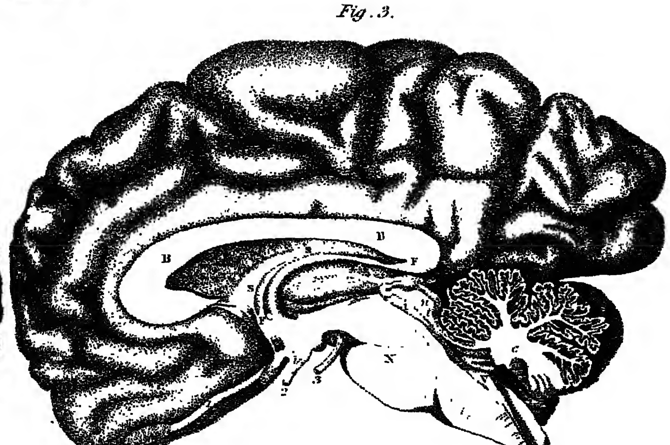

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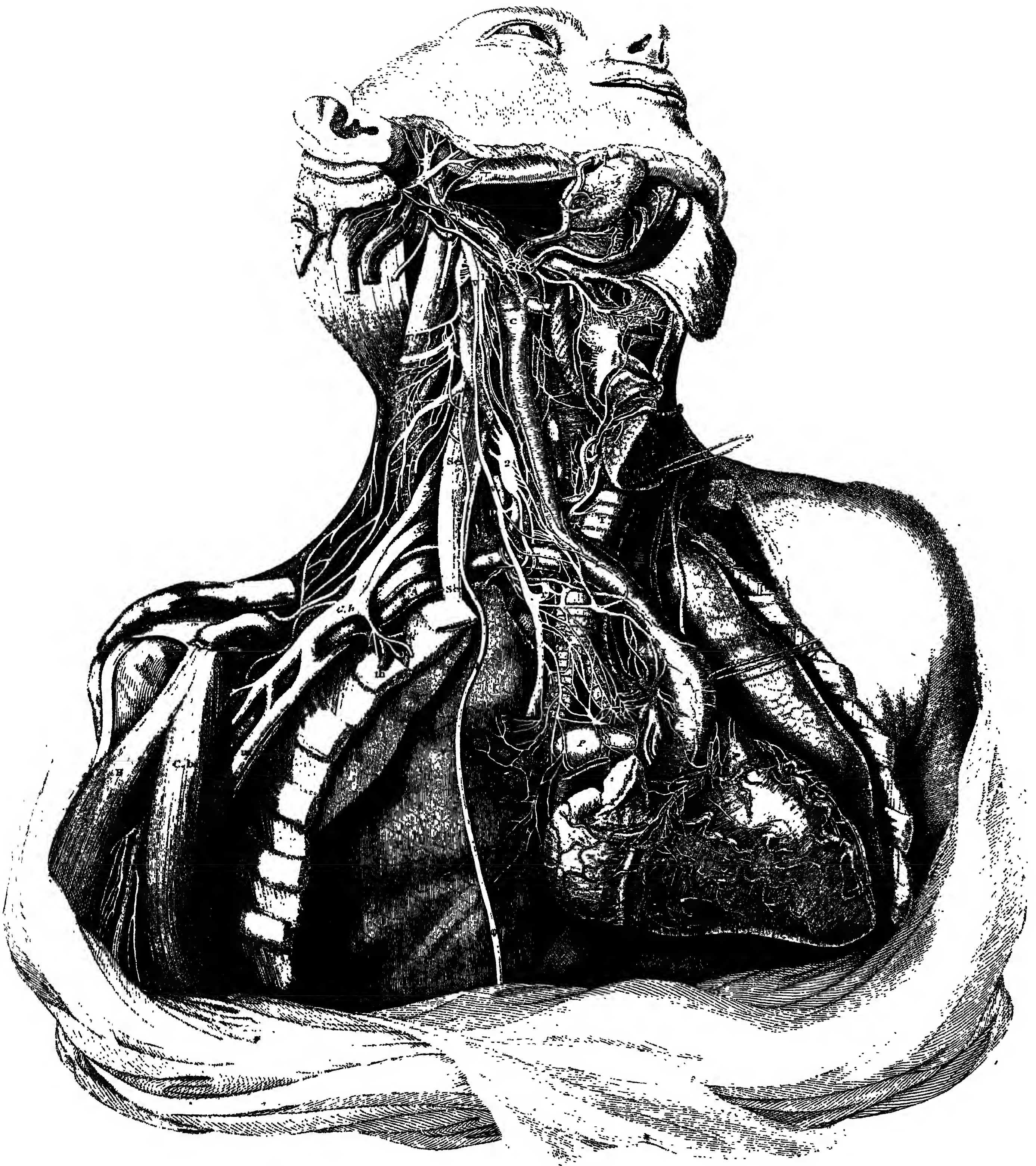

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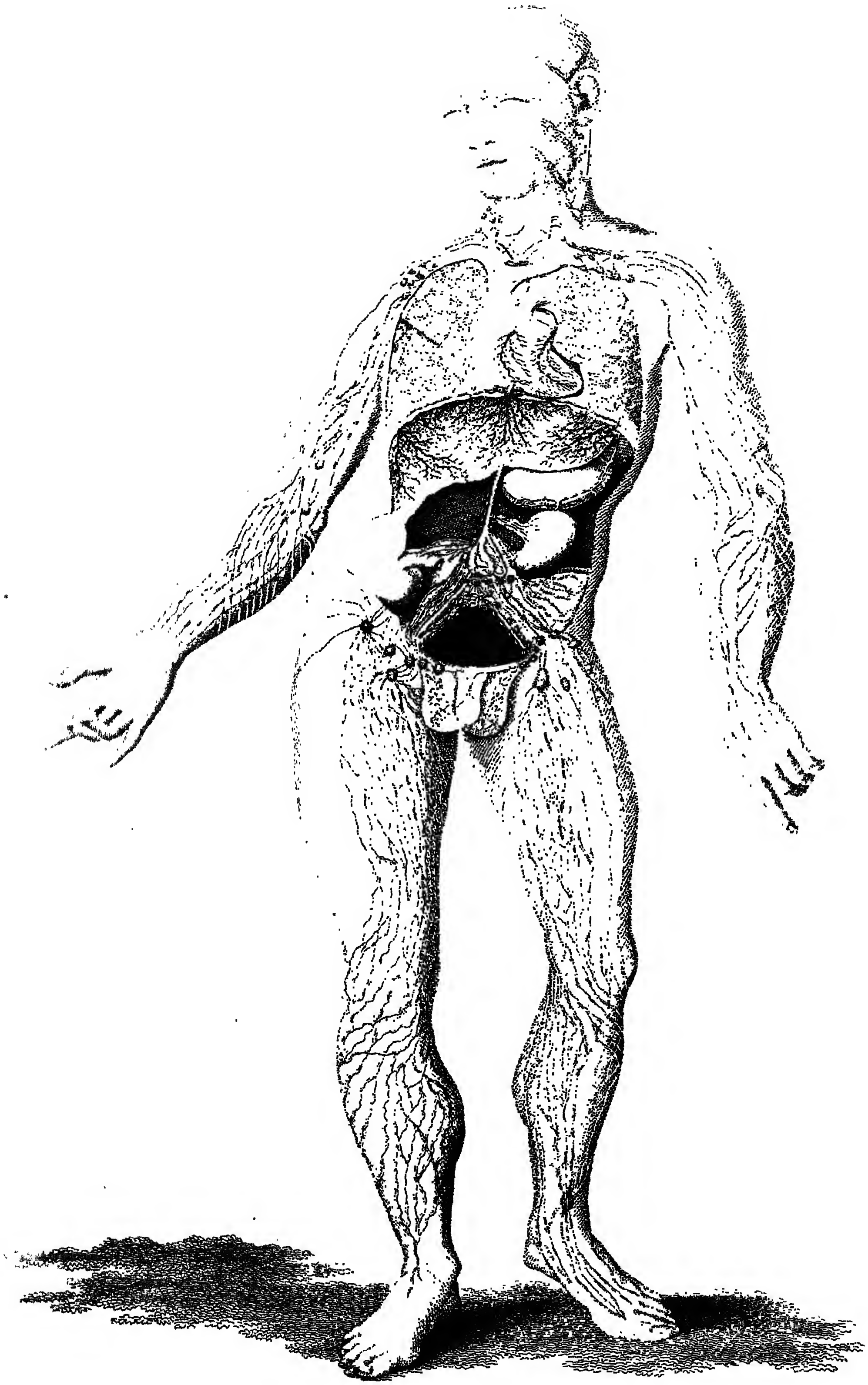

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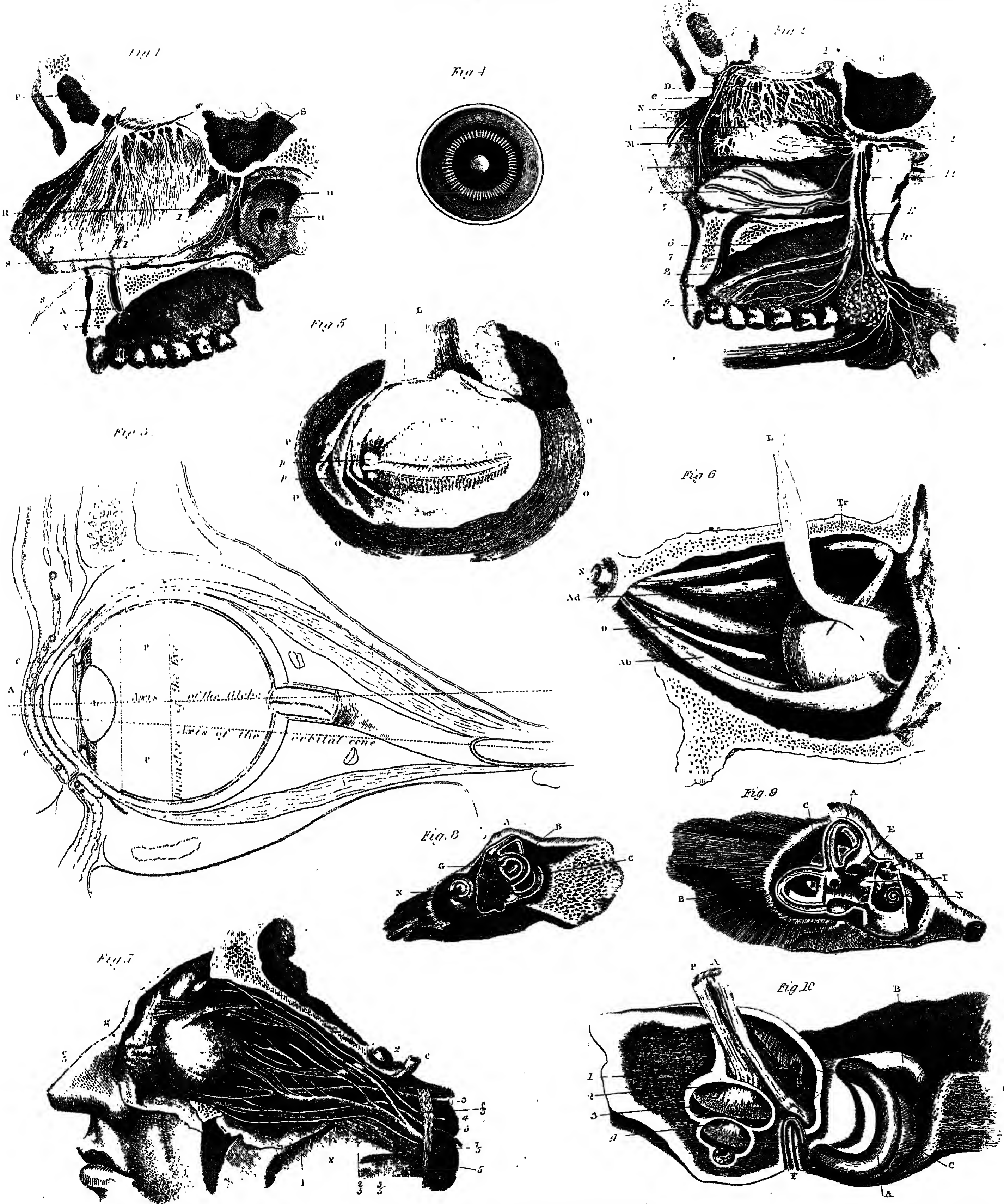

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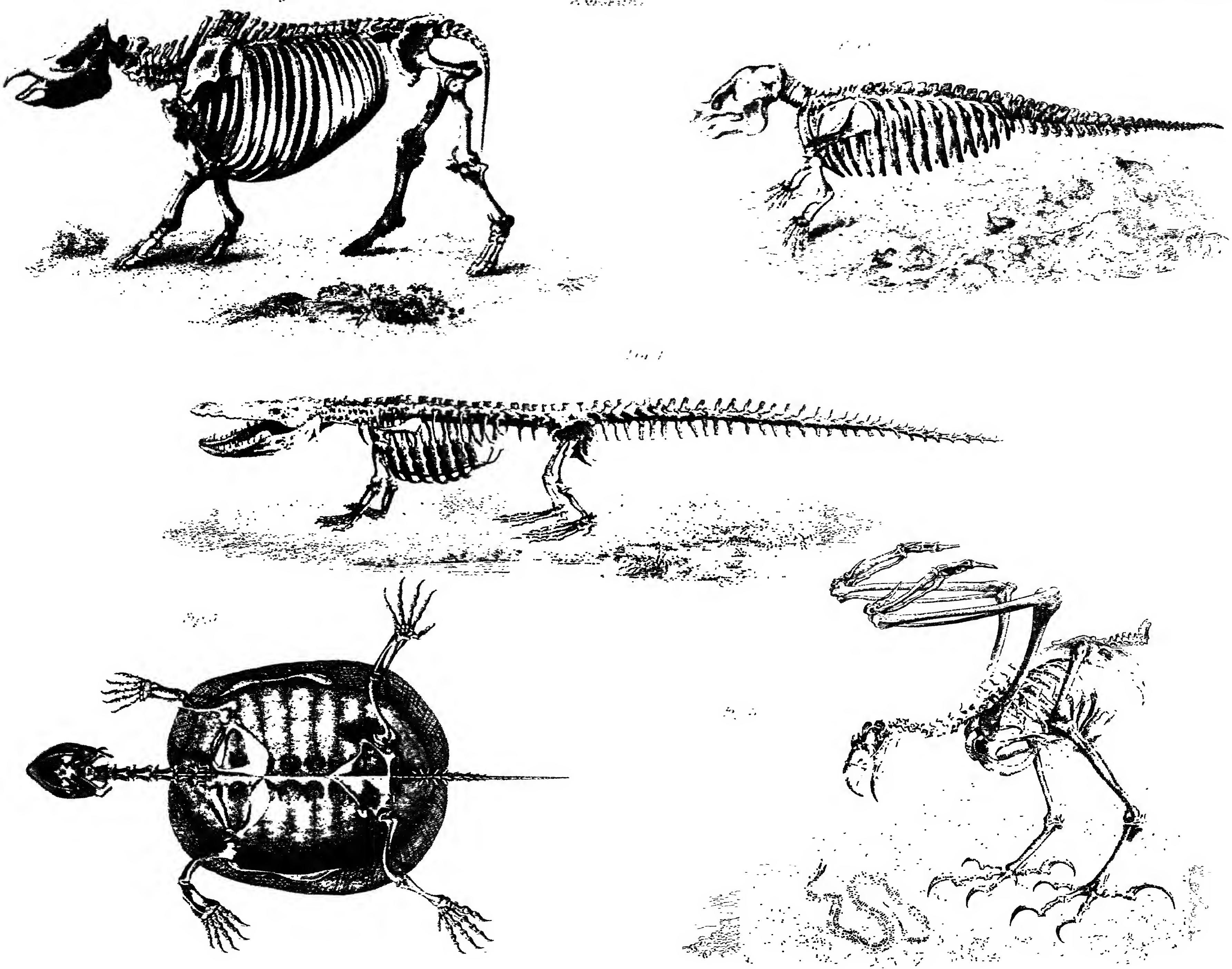
PLATE XXXIV.



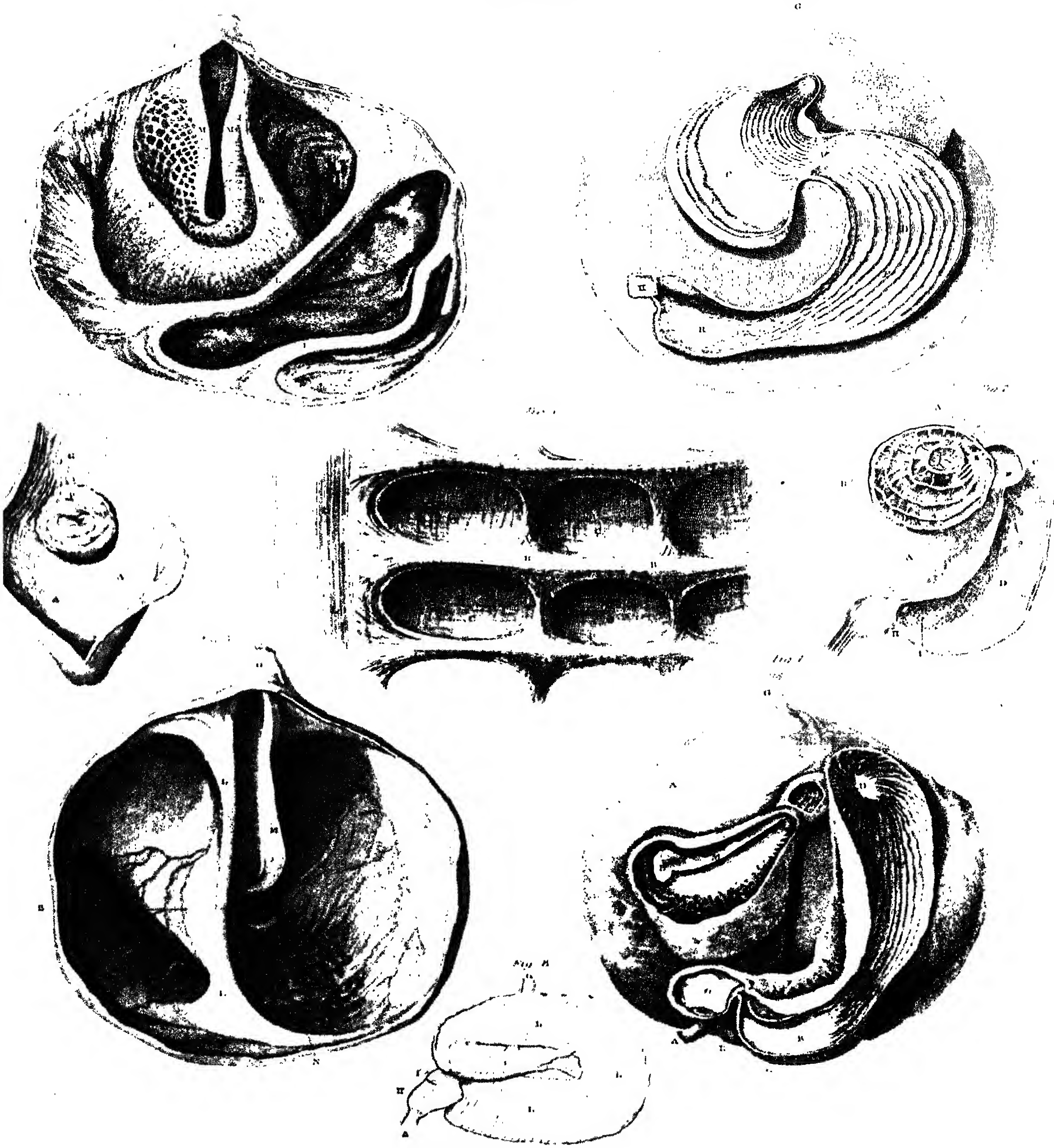


Fig. 1

Fig. 2

Fig. 3

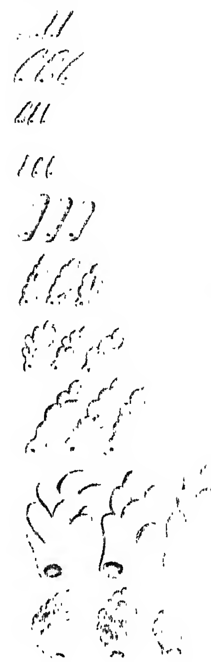


Fig. 4

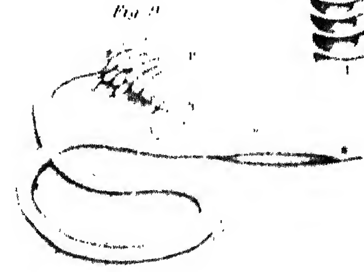
Fig. 5

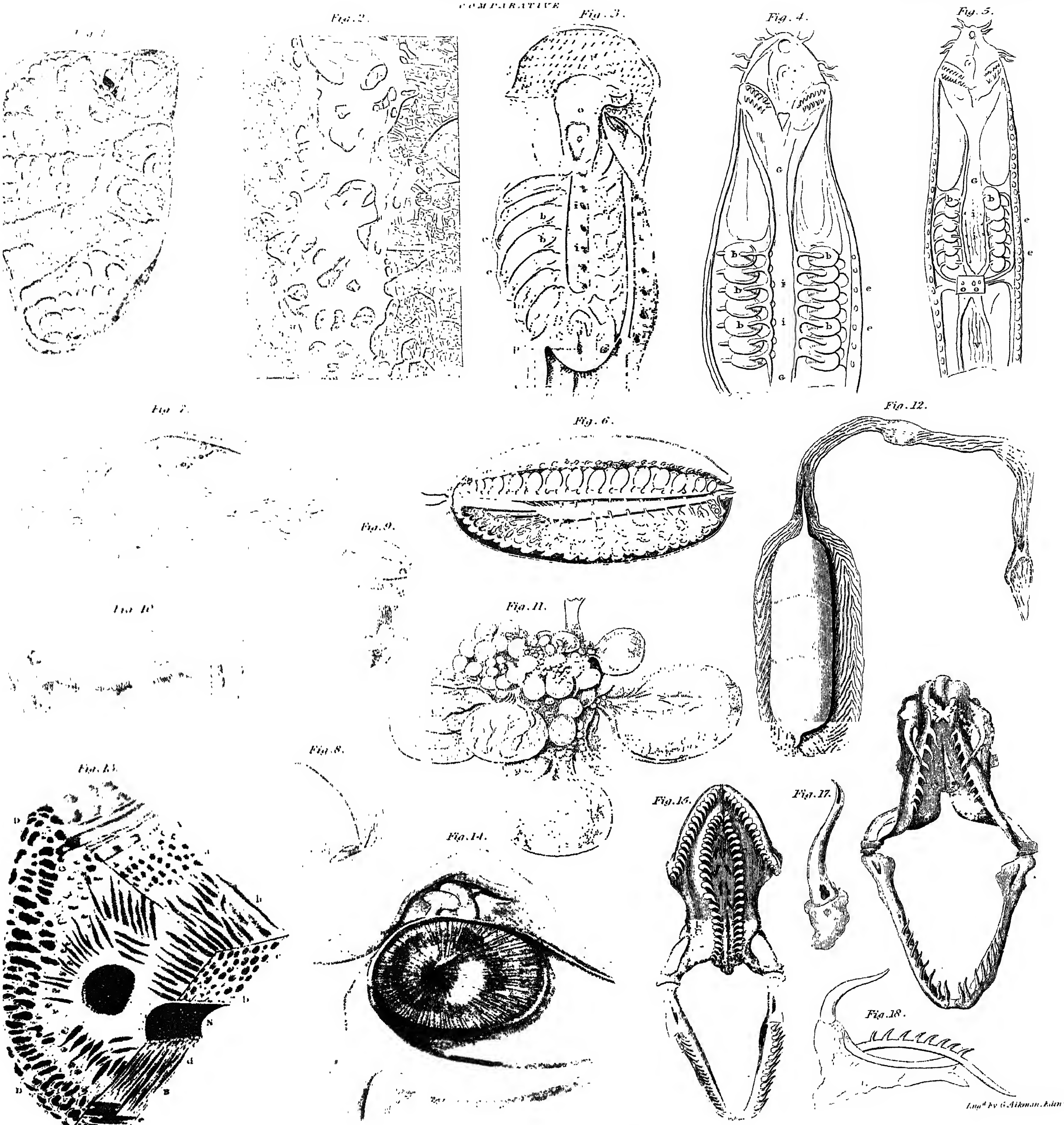
Fig. 6

Fig. 7

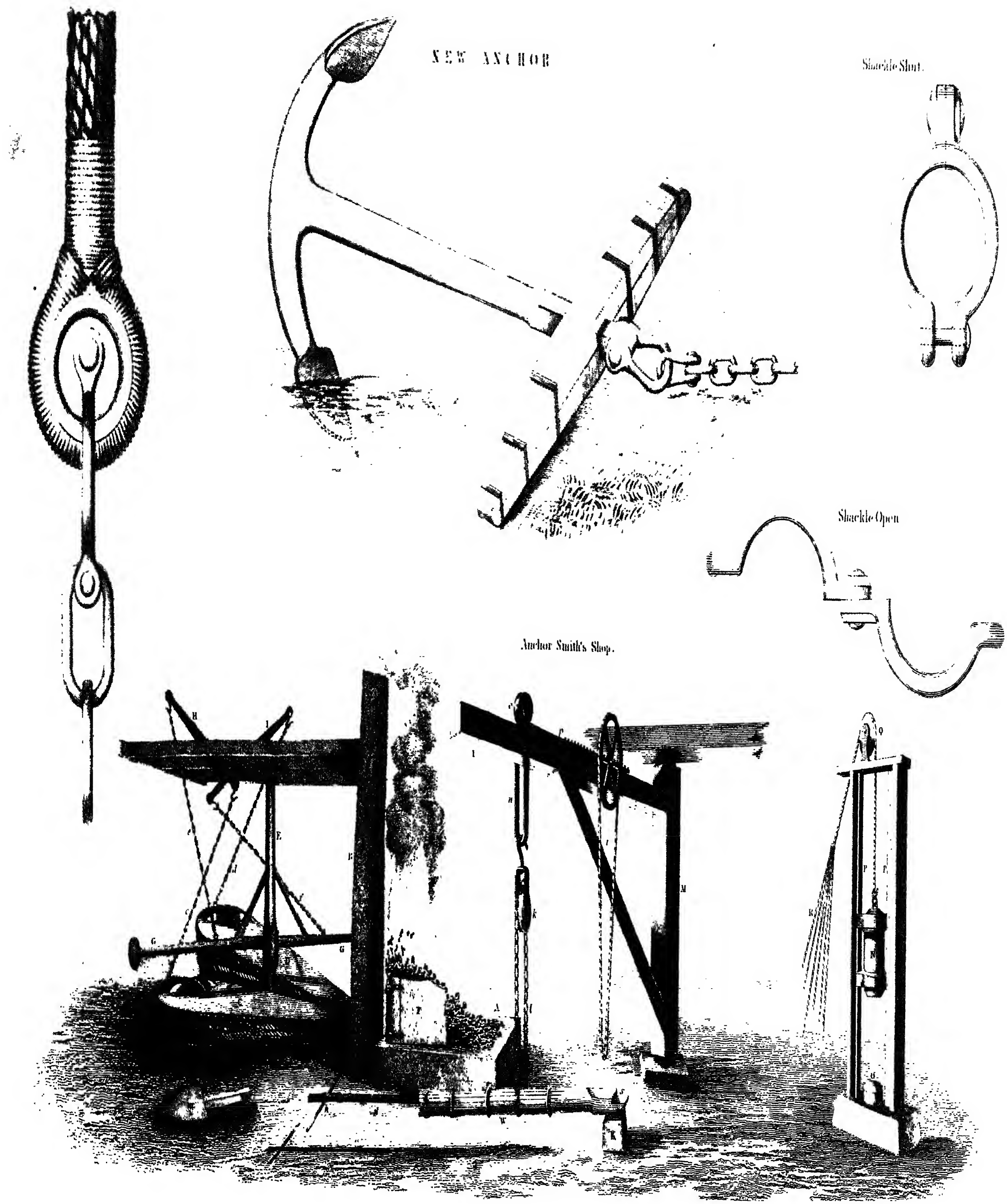
Fig. 8

Fig. 9



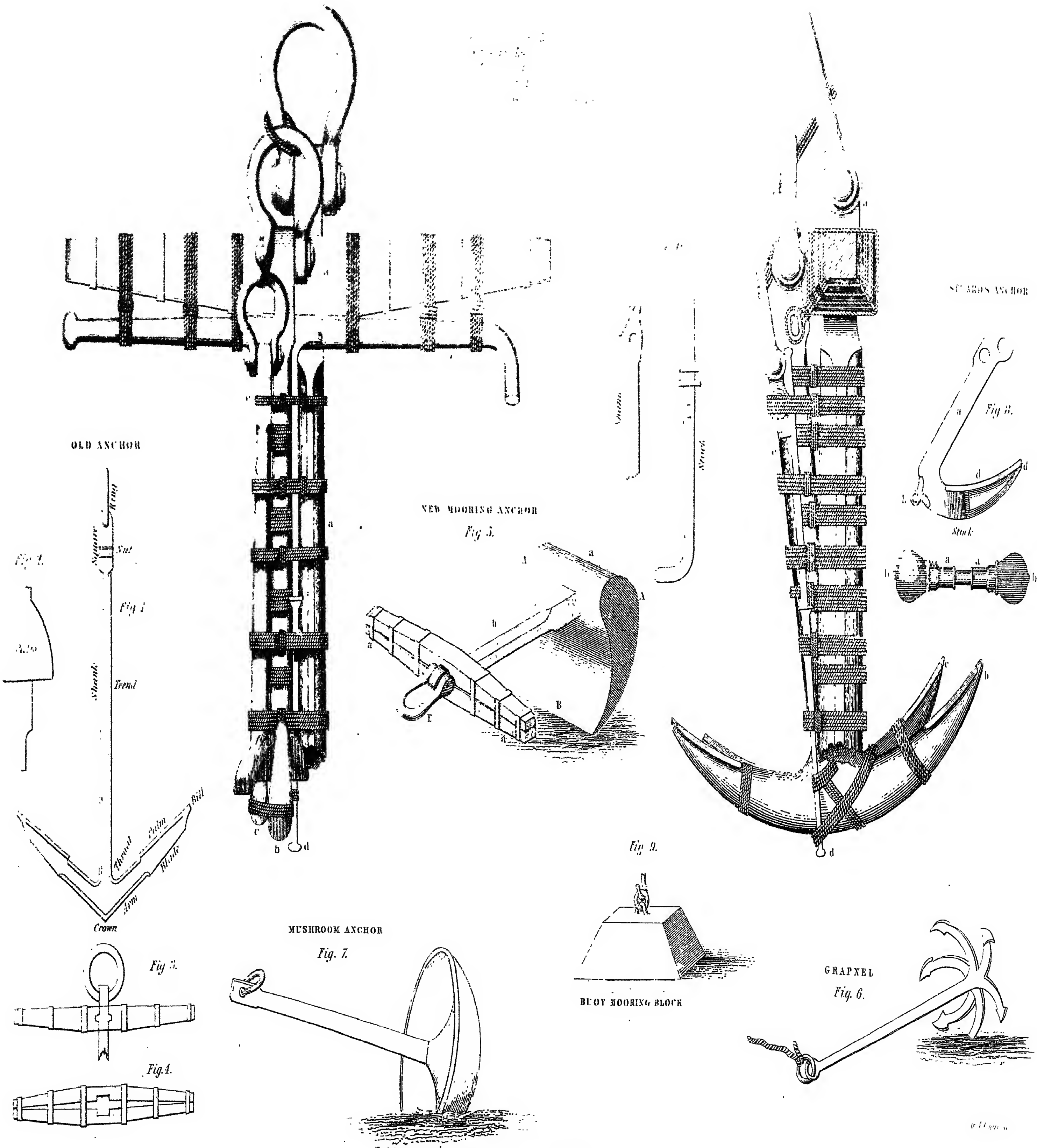


Published by A & C Black, Edinburgh


NEW ANCHOR
Shackle Shut.
Shackle Open
Anchor Smith's Shop.

ANCHOR.

PLATE XXXIX

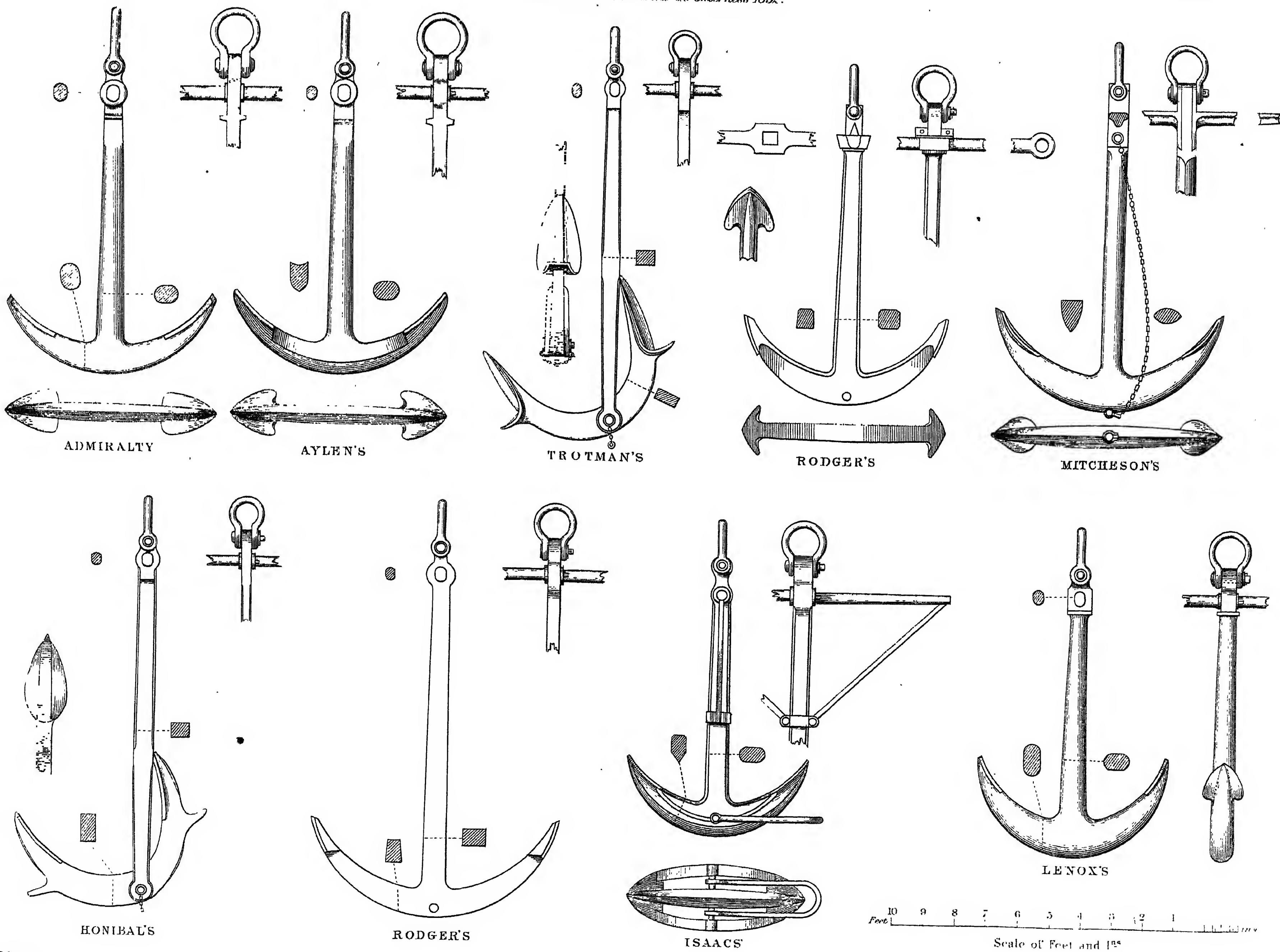


Published by A & C. Black. Edinburgh. 1853

ANCHOR.

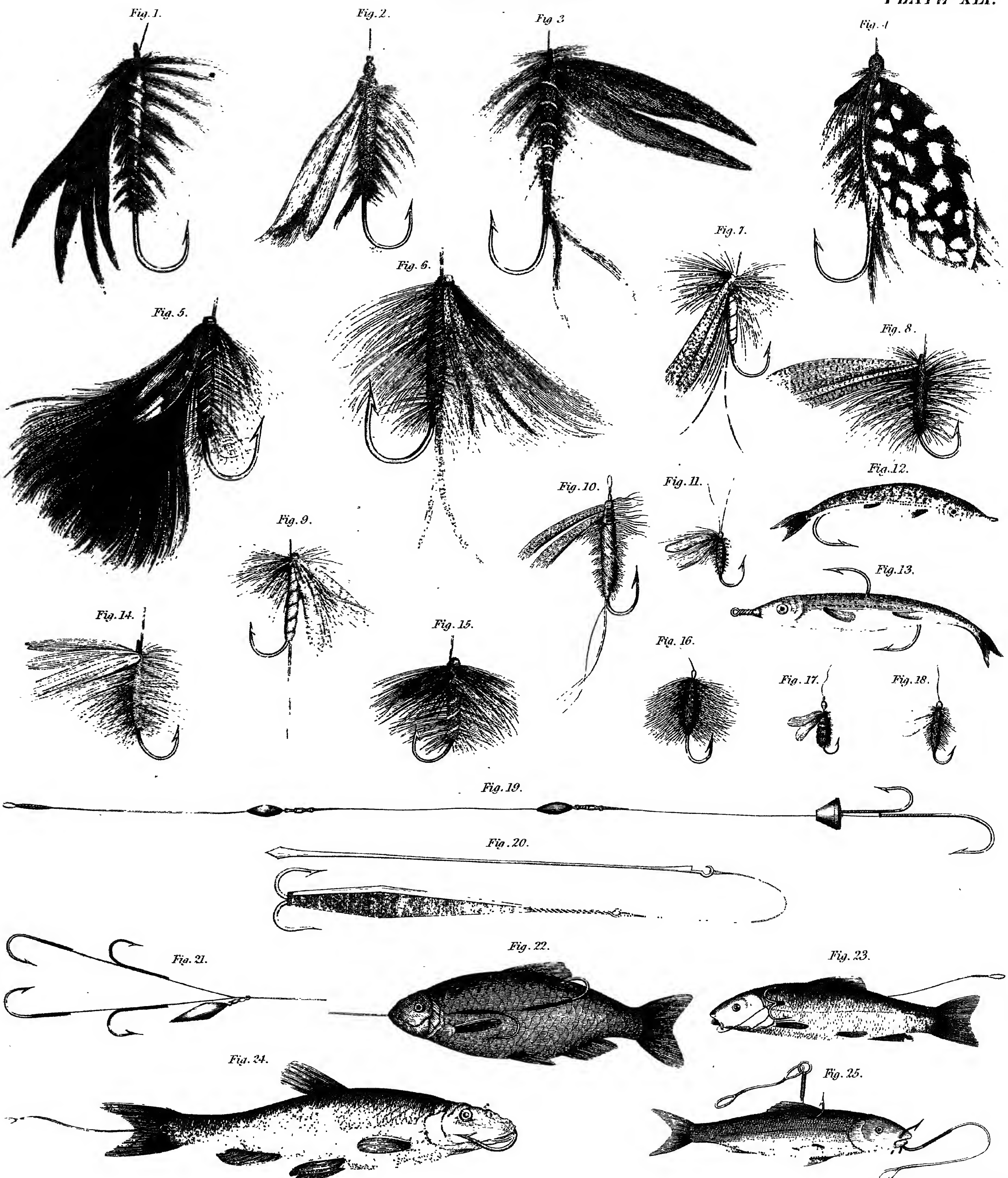
Sketch of Anchors tried at Sheerness 1852.

PLATE XL.



Published by A & C Black Edinburgh 1853

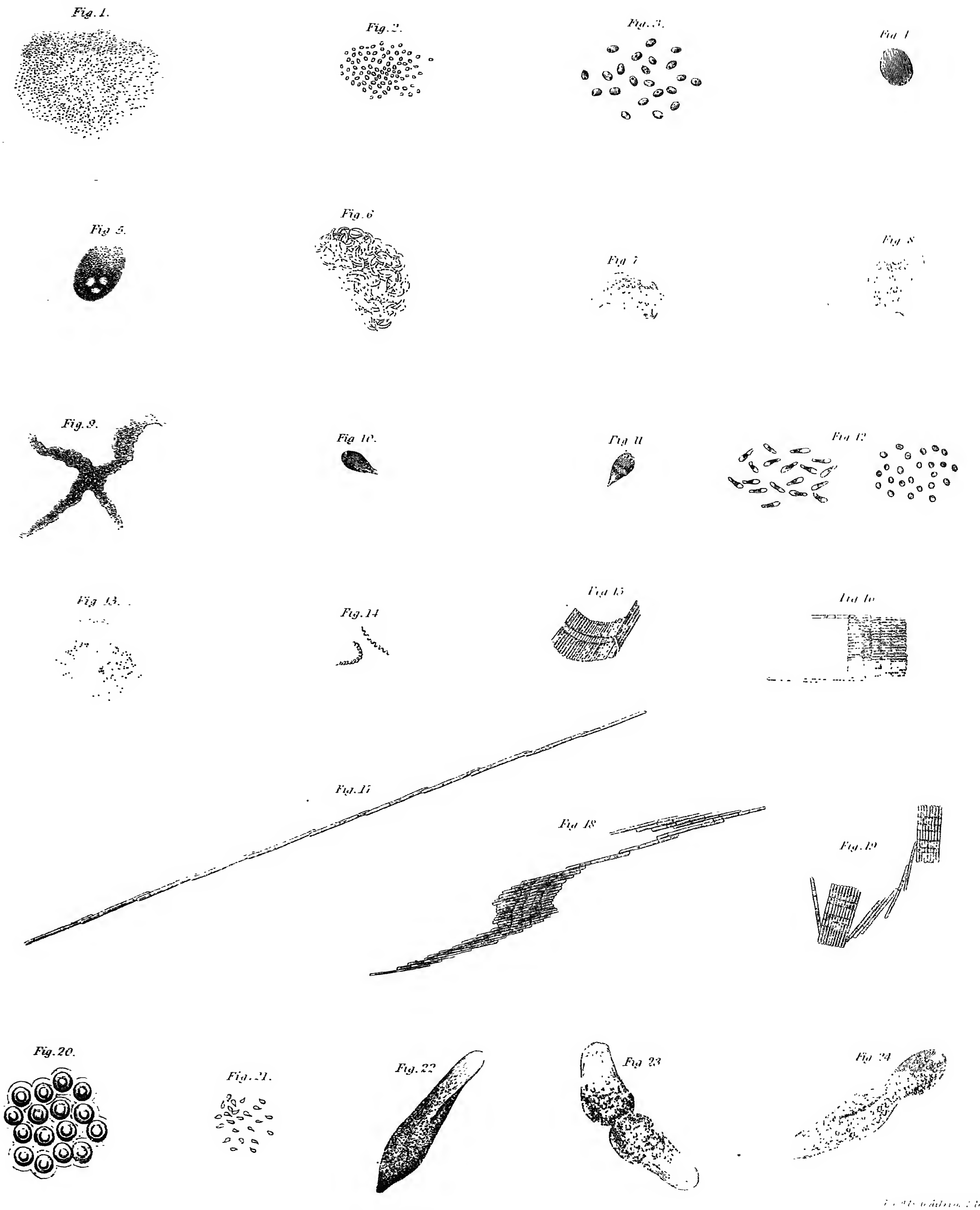
ANGLING. **PLATE XLI.**



Published by A. & C. Black Edinburgh

ANIMALCULES.

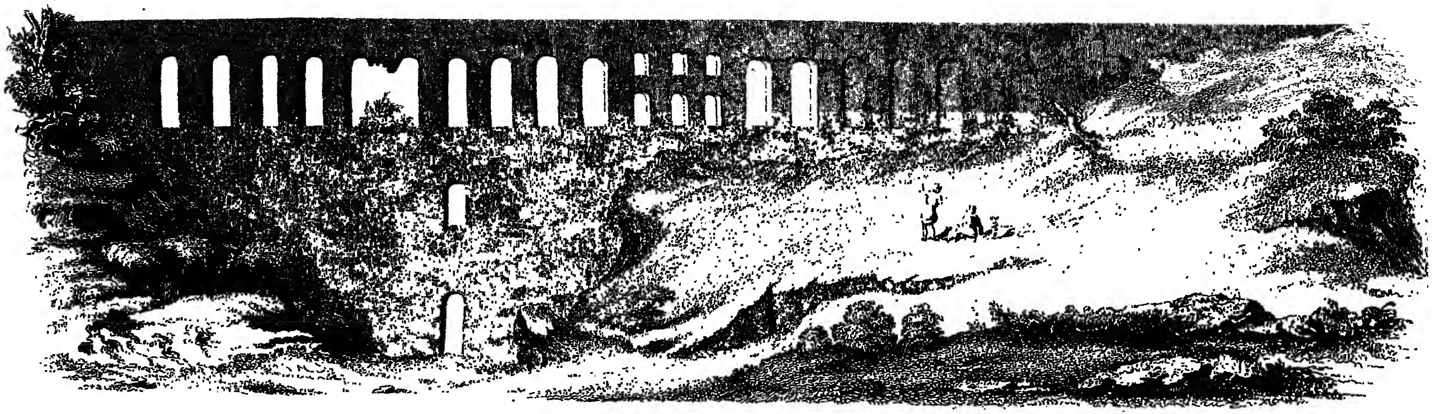
PLATE XLII.



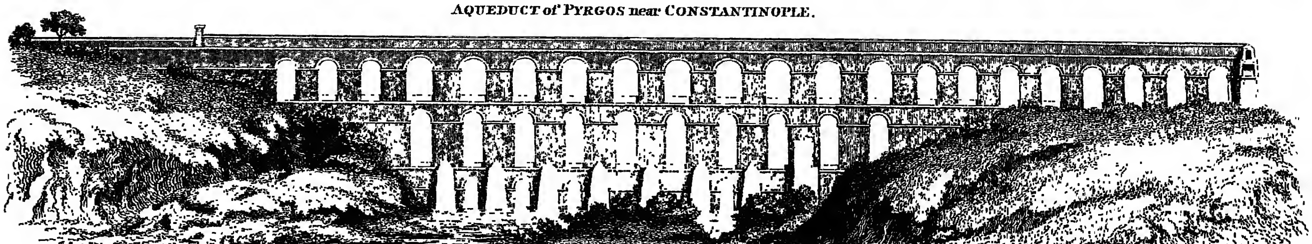
Published by A & C Black Edinburgh

AQUEDUCT.

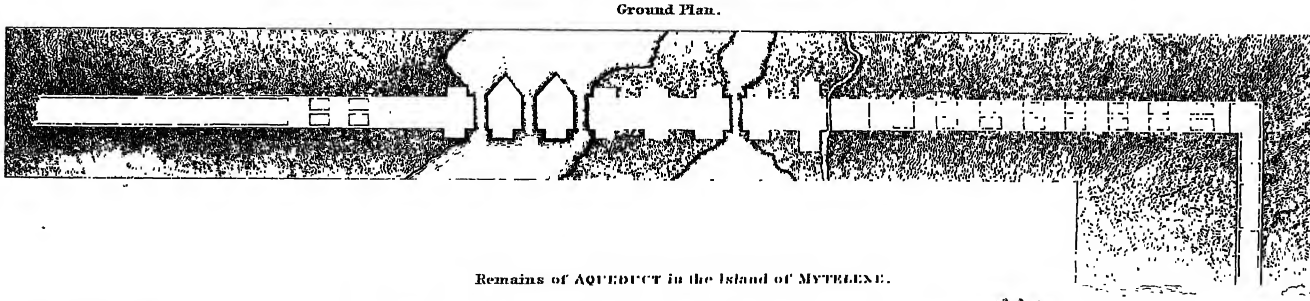
Remains of AQUEDUCT near ANTIOCH.



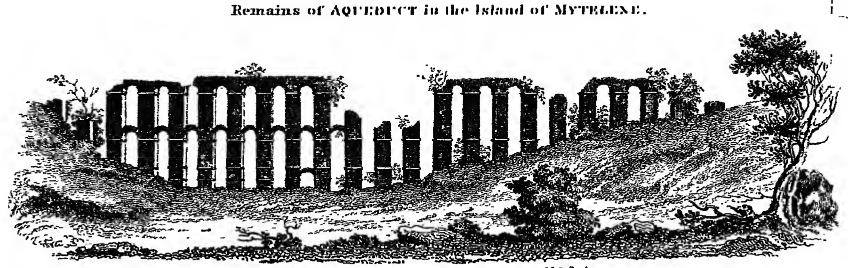
AQUEDUCT of PYRGOS near CONSTANTINOPLE.



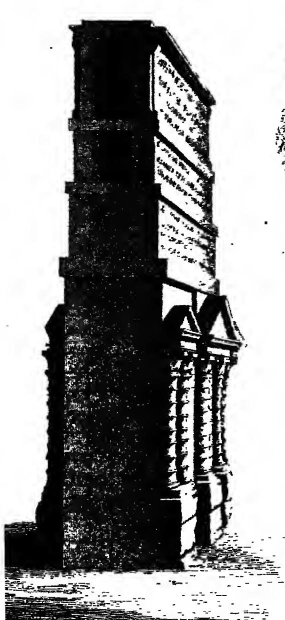
Ground Plan.



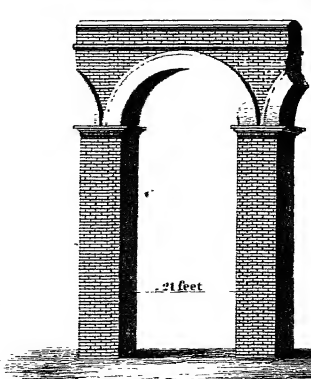
Remains of AQUEDUCT in the Island of MYTELENE.

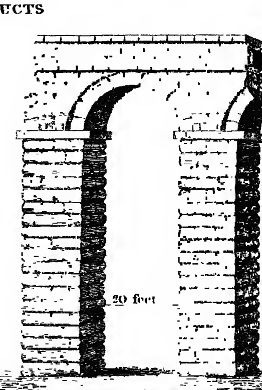


ROMAN AQUEDUCT.

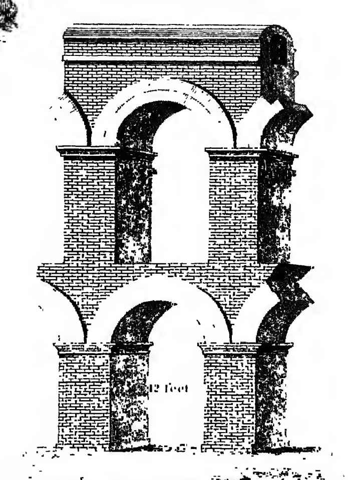


ROMAN AQUEDUCTS





ROMAN AQUEDUCT.



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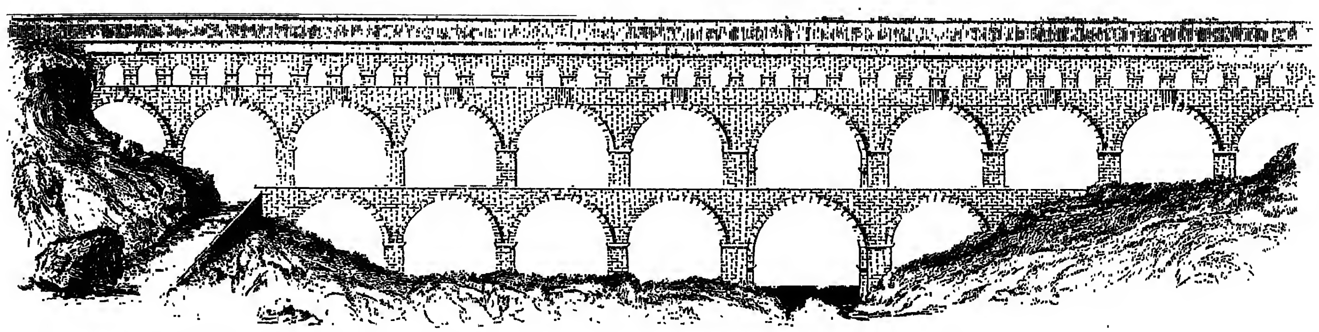
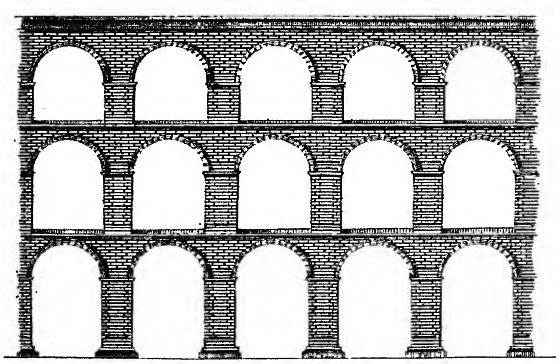
AQUEDUCT.

Remains of AQUEDUCT of METZ.

AQUEDUCT or PONT du GARD near NISMES.



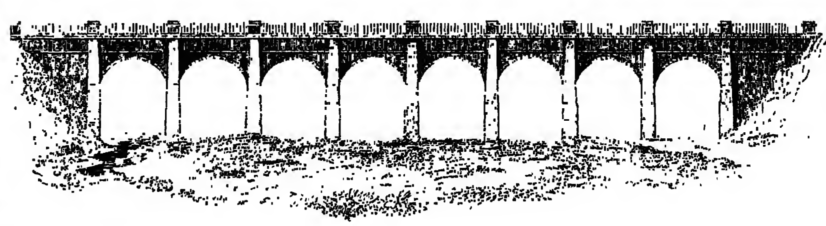
AQUEDUCT of MAINTENON.



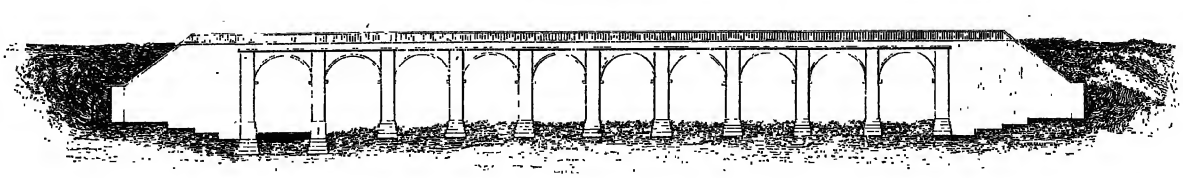
Scale to all the Aqueducts on Plate.

150 feet

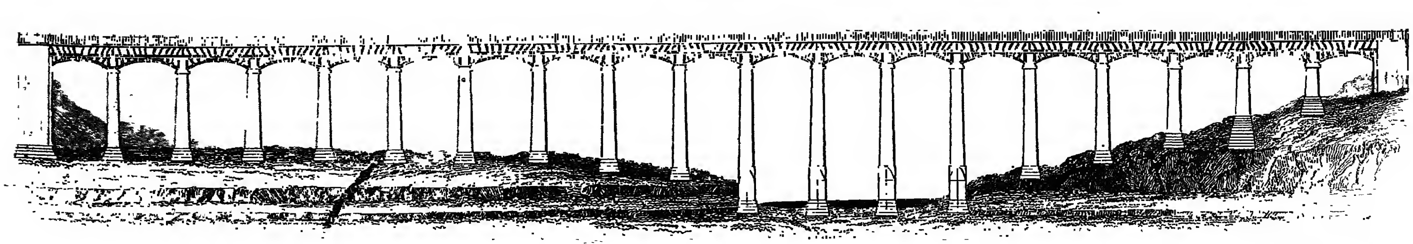
AQUEDUCT of SLATEFORD near EDINBURGH.



CHIRK AQUEDUCT.



PONT CYSYLTE AQUEDUCT.



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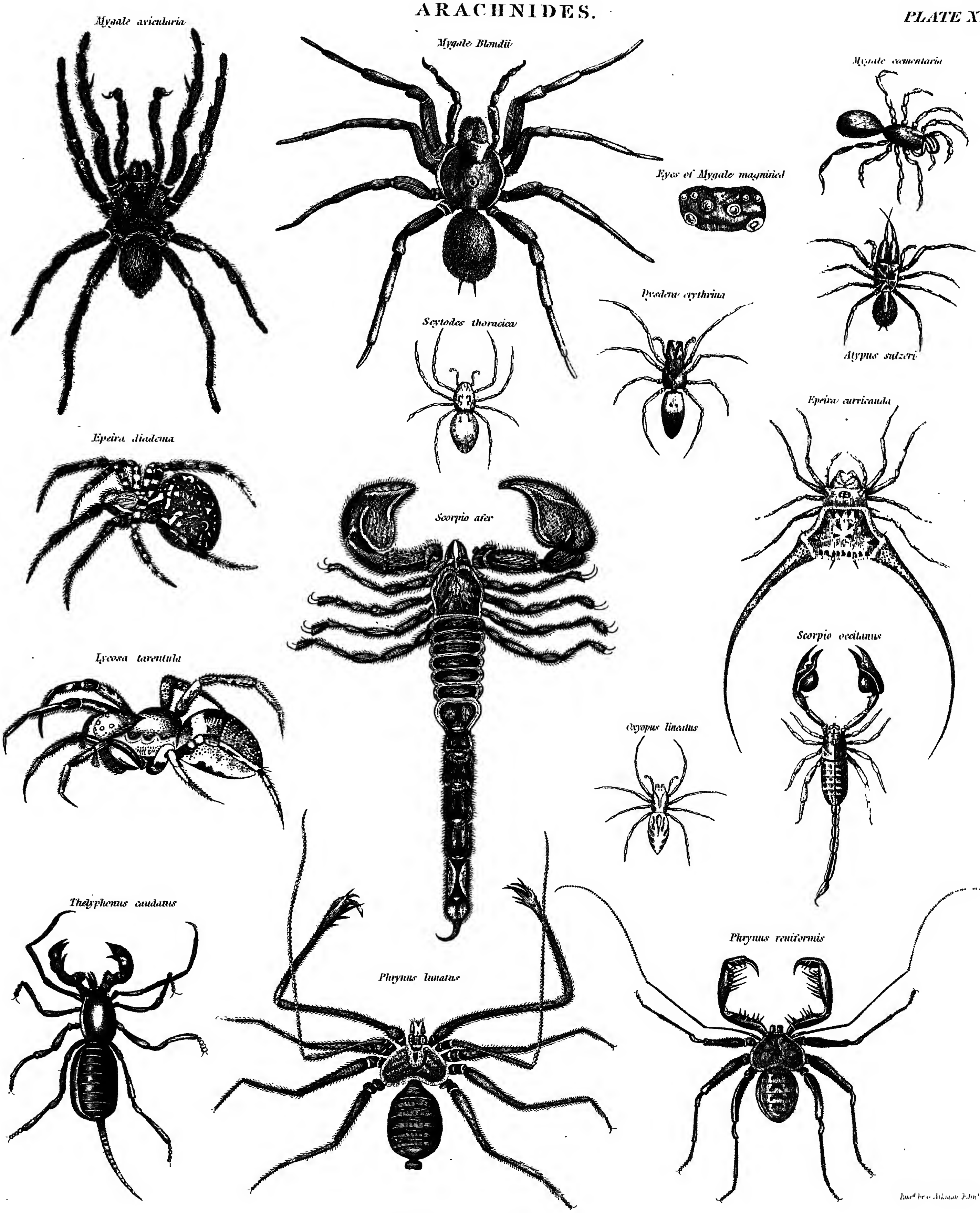
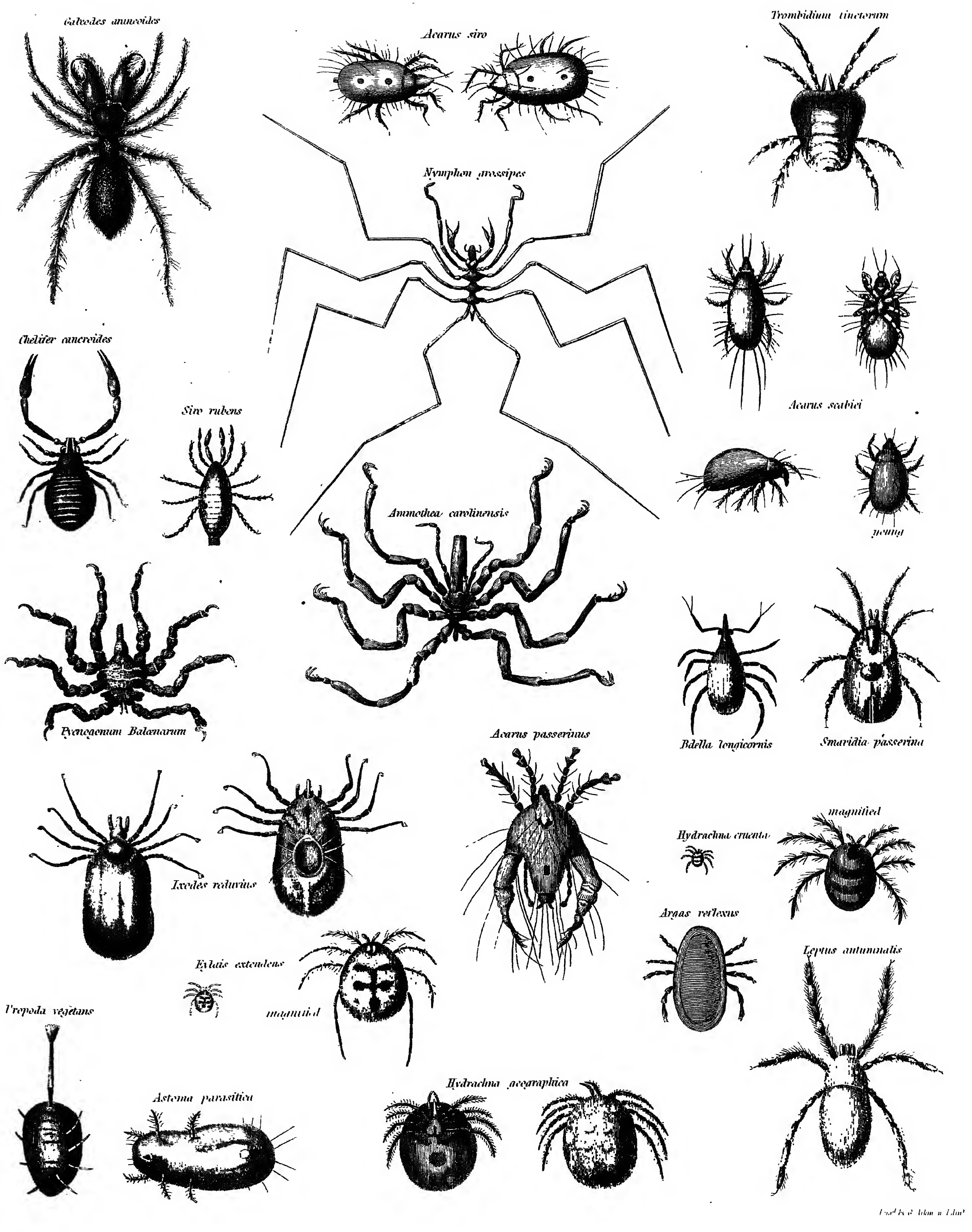


Published by A.&C. Black Edinburgh


Galeodes araneoides
Acarus siro
Trombidium tinctorum
Nymphon grossipes
Chelifer cancroides
Siro rubens
Acarus scabiei
young
Ammothea carolinensis
Pycnogonum Balænarum
Bdella longicornis
Smaridia passerina
Acarus passerinus
Hydrachna cruenta
magnified
Ixodes reduvius
Argas reflexus
Eylais extendens
magnified
Leptus autumnalis
Uropoda vegetans
Astoma parasitica
Hydrachna geographica

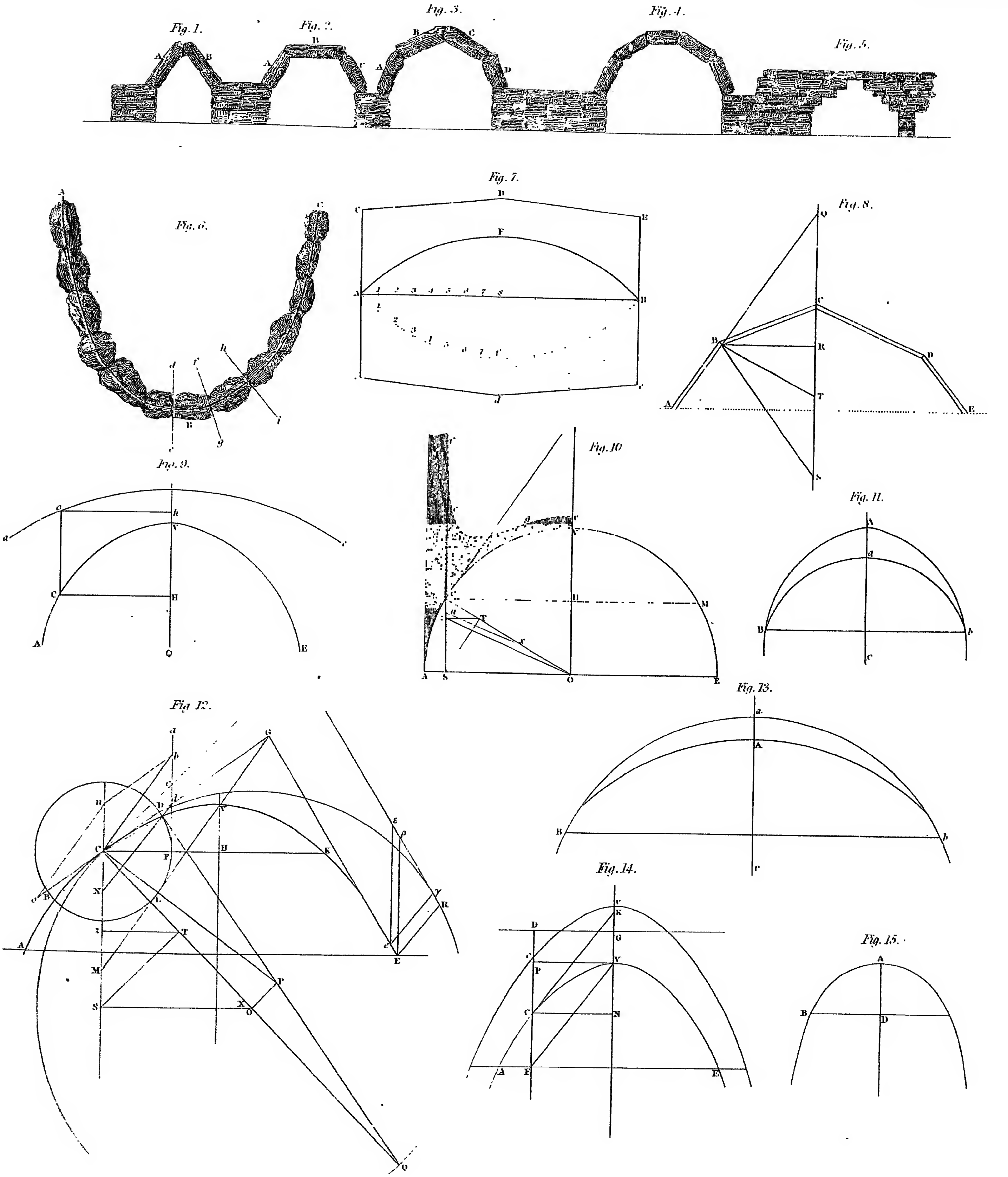


Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.
Fig. 7.
Fig. 8.
Fig. 9.
Fig. 10
Fig. 11.
Fig. 12.
Fig. 13.
Fig. 14.
Fig. 15.

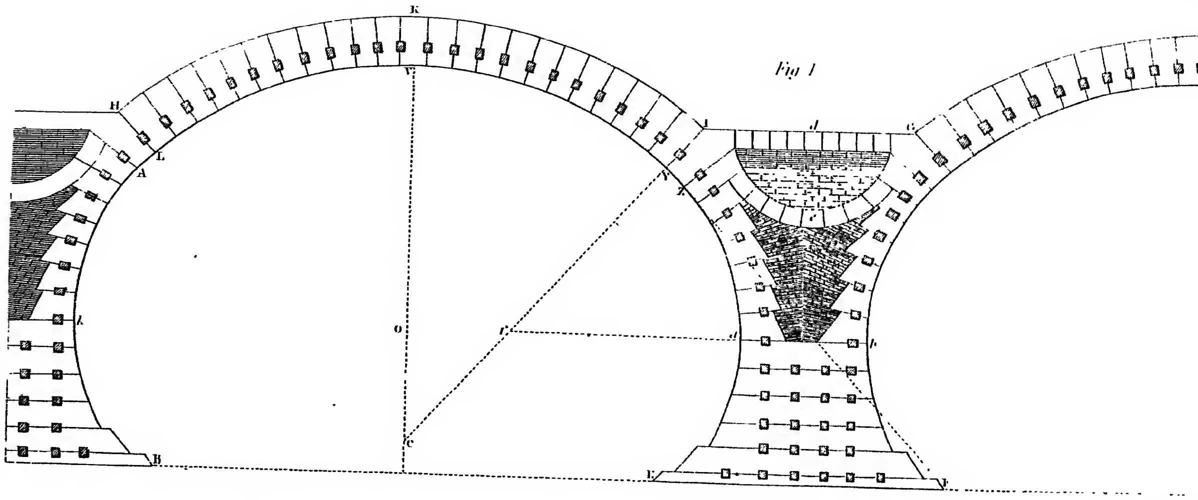


Fig. 1.

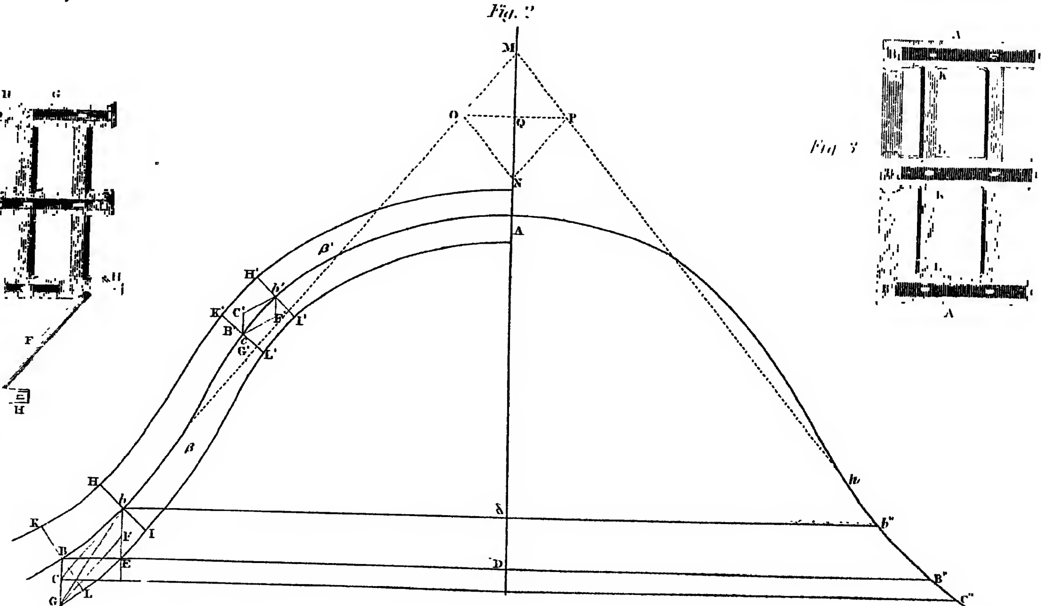


Fig. 2.

Fig. 3.

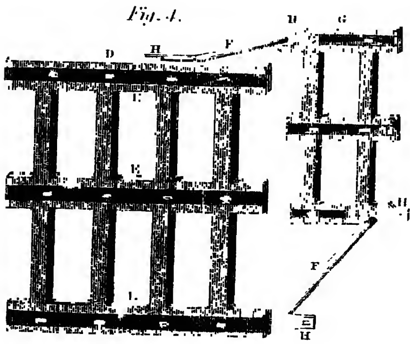


Fig. 4.

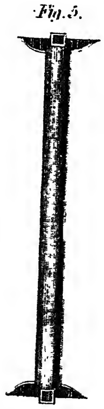


Fig. 5.

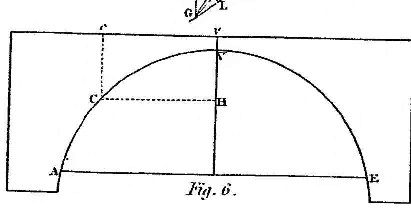


Fig. 6.

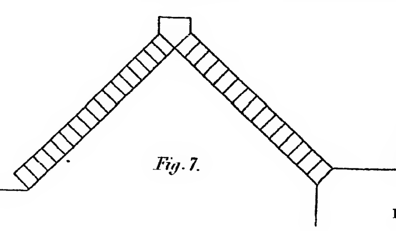


Fig. 7.

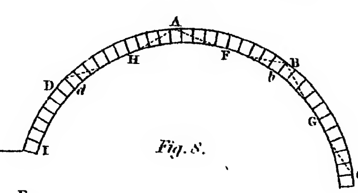


Fig. 8.

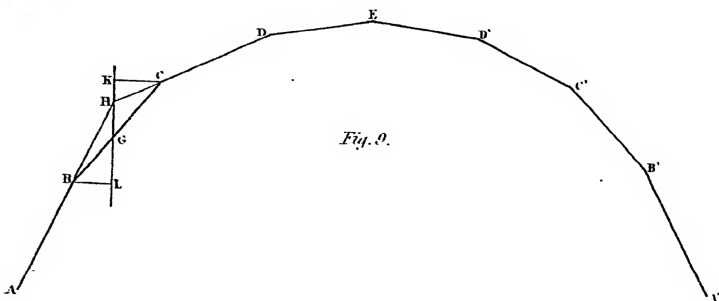


Fig. 9.

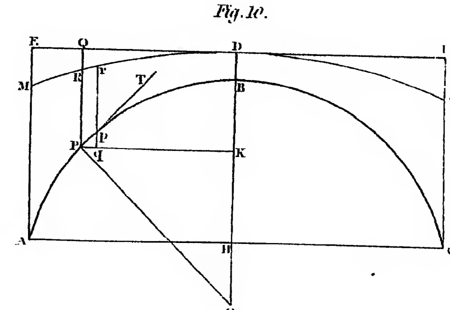
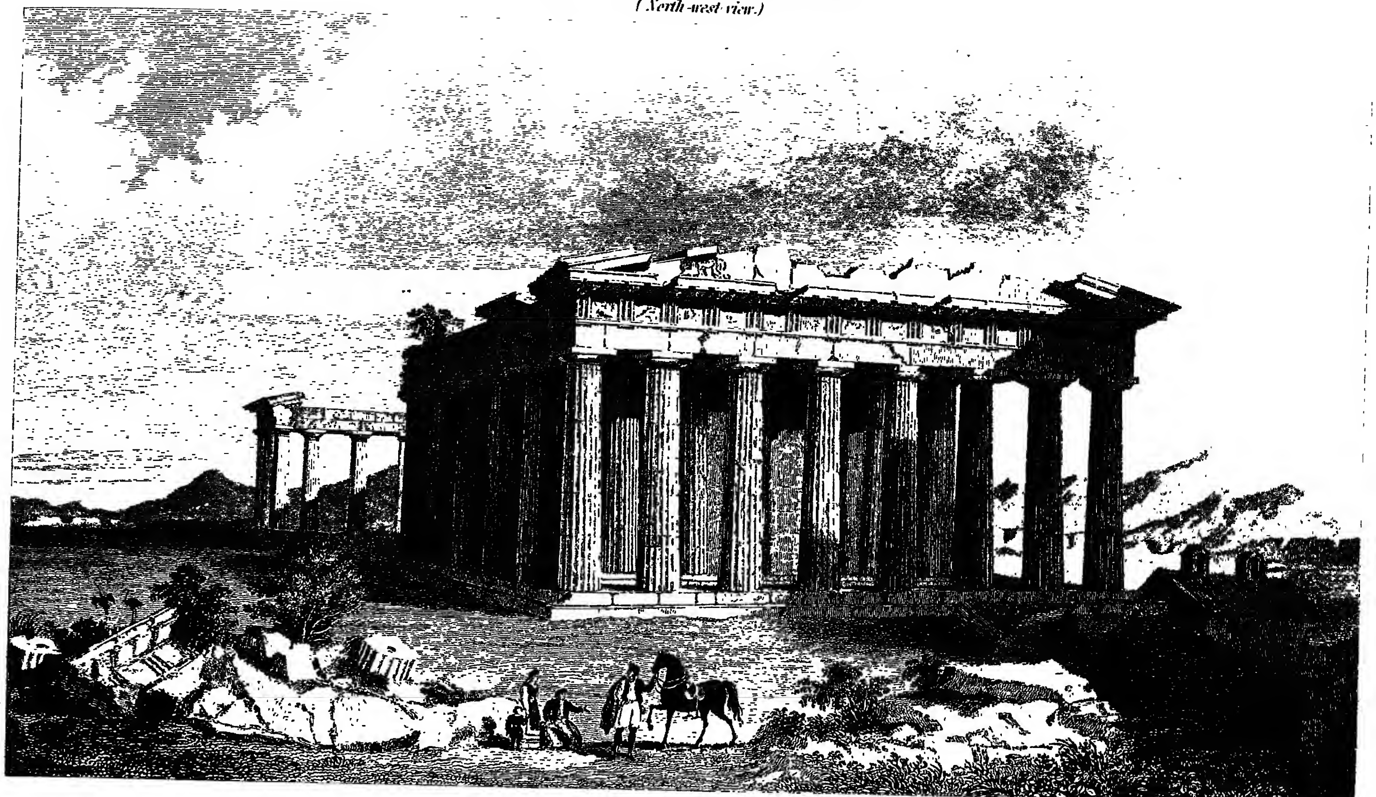
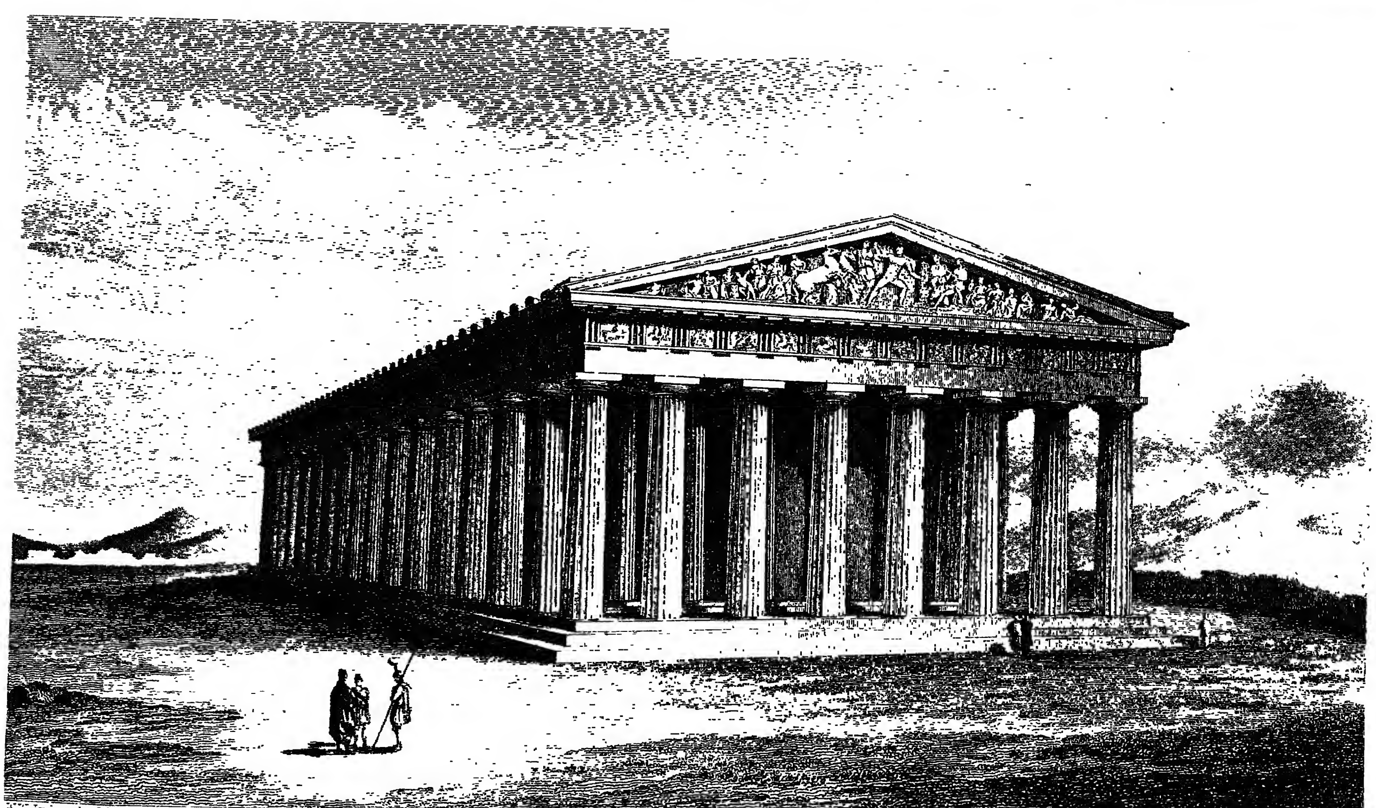


Fig. 10.

The Temple of Minerva Parthenon at Athens.
(North-west view.)



In its present state.



Restored

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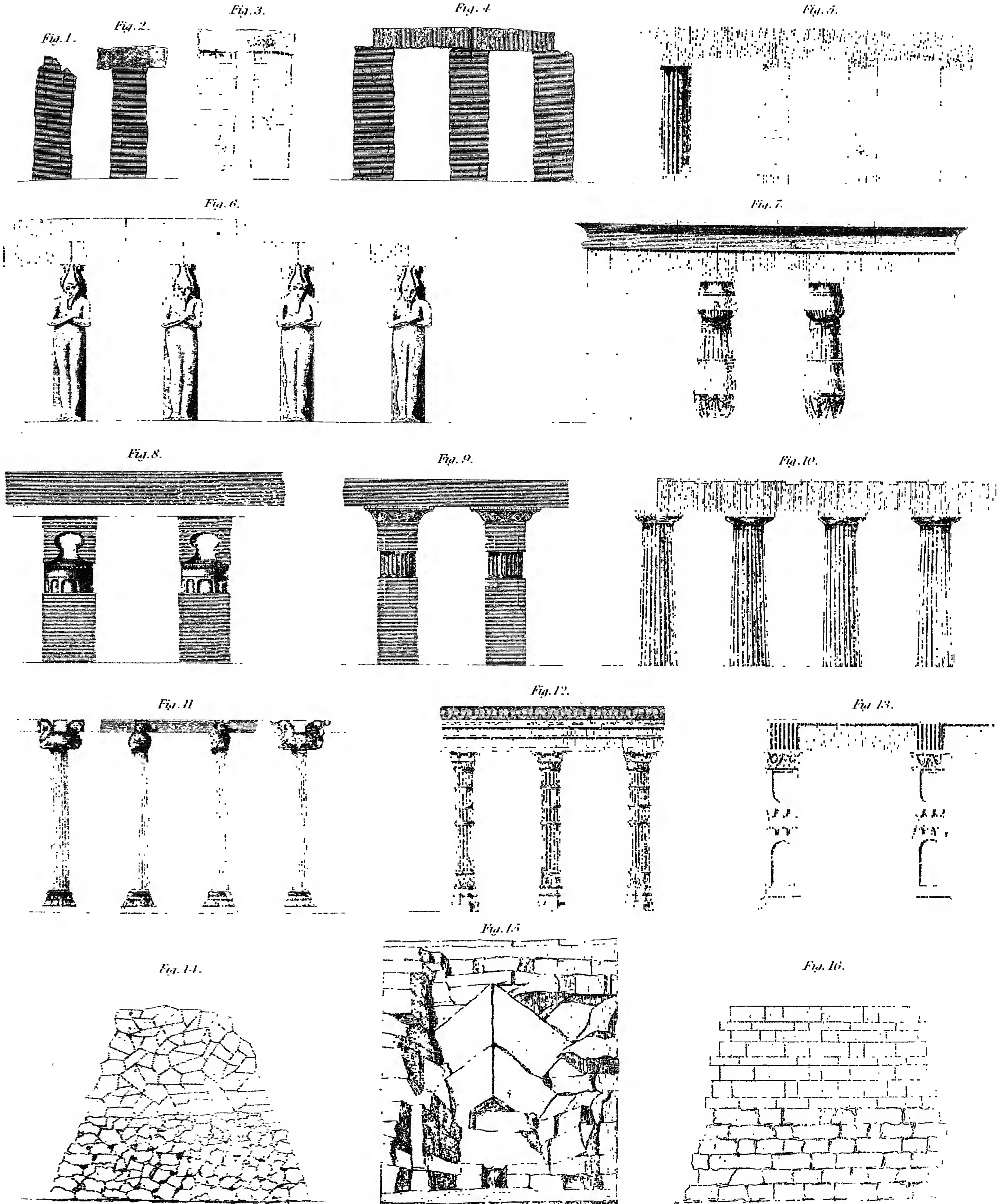

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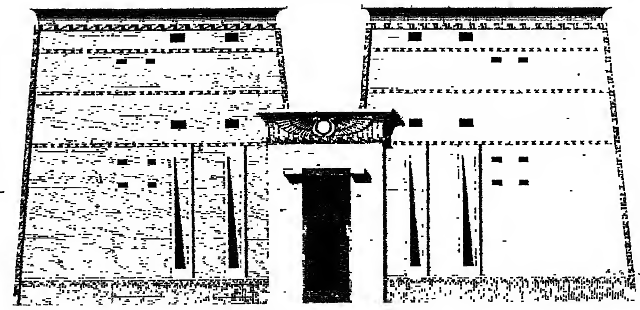
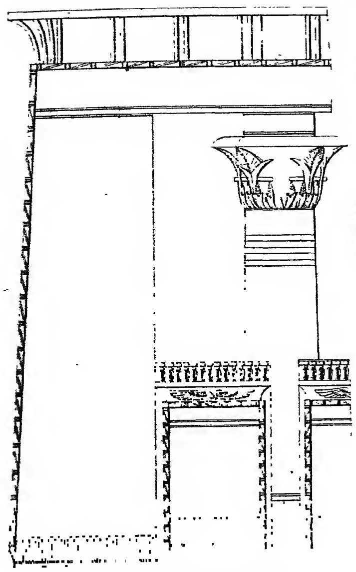
Plan, Section and Elevations of the Temple of Apollinopolis Magna in Upper Egypt.

Fig. 1.



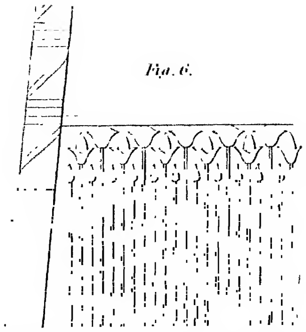
Elevation of Propylæa.

Fig. 5.



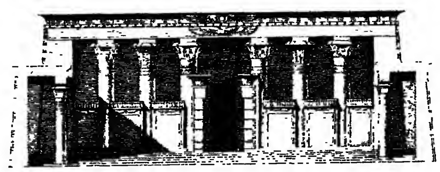
Part of Elevation of Pronaos at an enlarged scale.

Fig. 6.



Angle torus & lotus enrichment to Propylæa at an enlarged scale.

Fig. 2.



Elevation of Pronaos.
(Section on the line B.B. of Plan.)

Fig. 7.

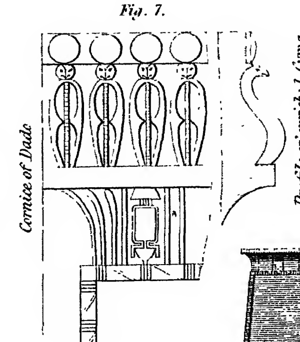
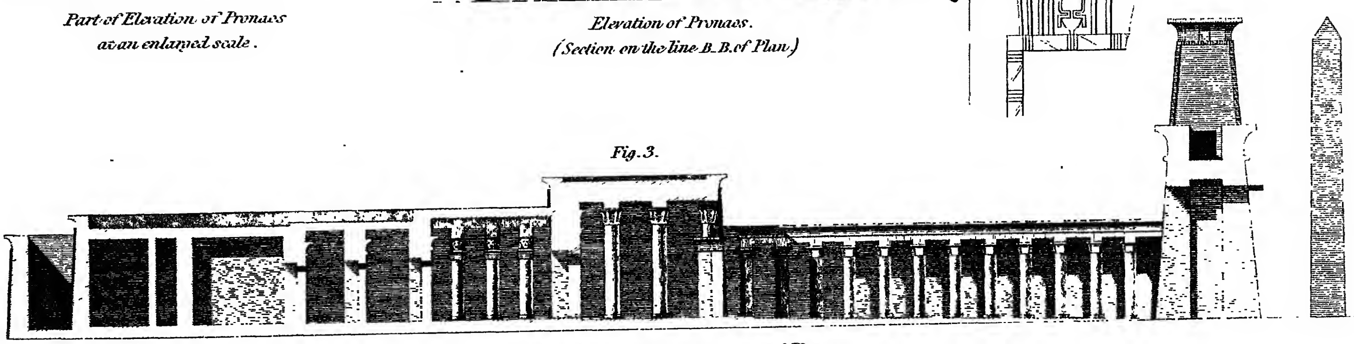
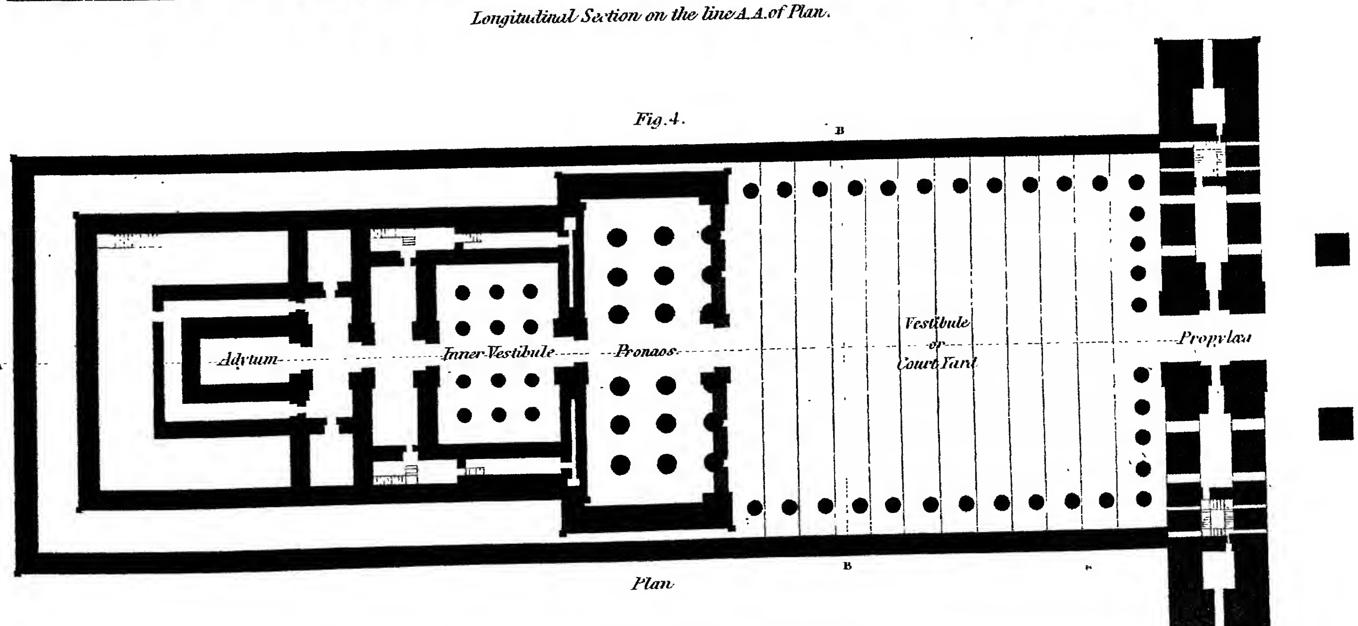


Fig. 3.



Longitudinal Section on the line A.A. of Plan.

Fig. 4.



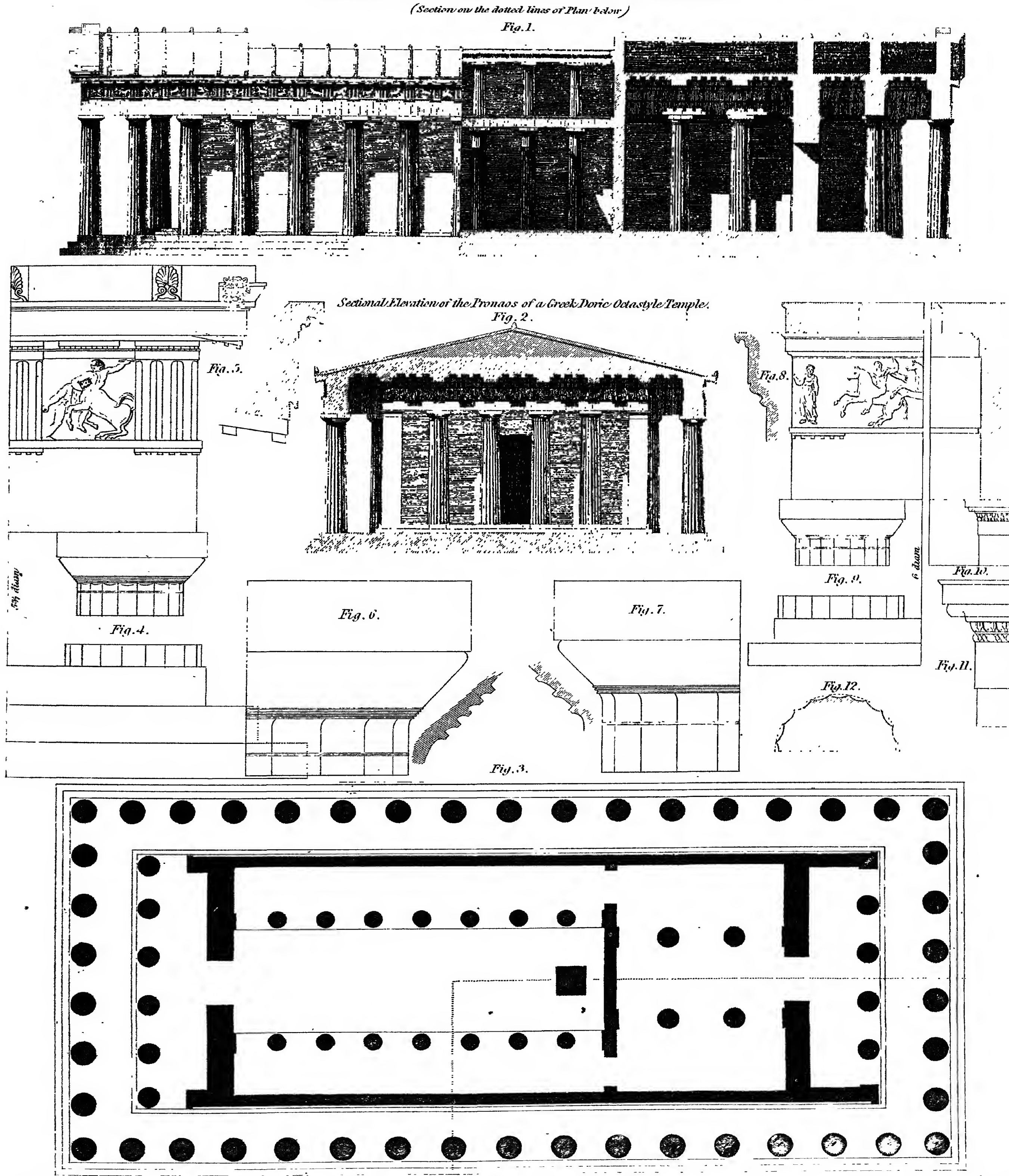
Plan

Published by A.&C. Black Edinburgh

W. H. del.

Eng^d by G. Aikman

Flank & Sectional Elevation of a Greek Doric Peripteral & Hypæthral Temple.
(Section on the dotted lines of Plan below)

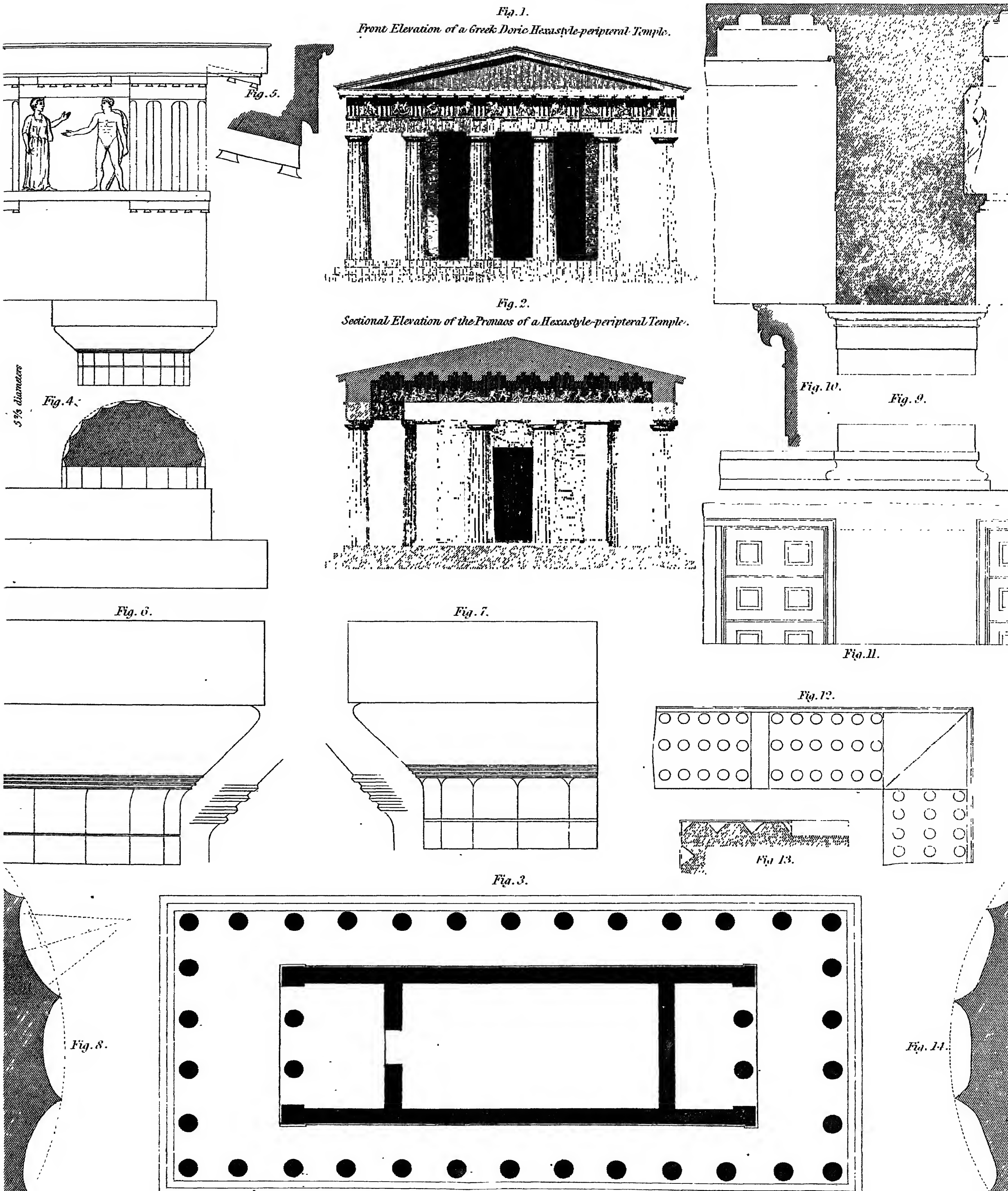


W H delt

Plan of a Greek Octastyle Peripteral & Hypæthral Temple.

Engd by G. Aikman Edin

Published by A & C Black, Edinburgh

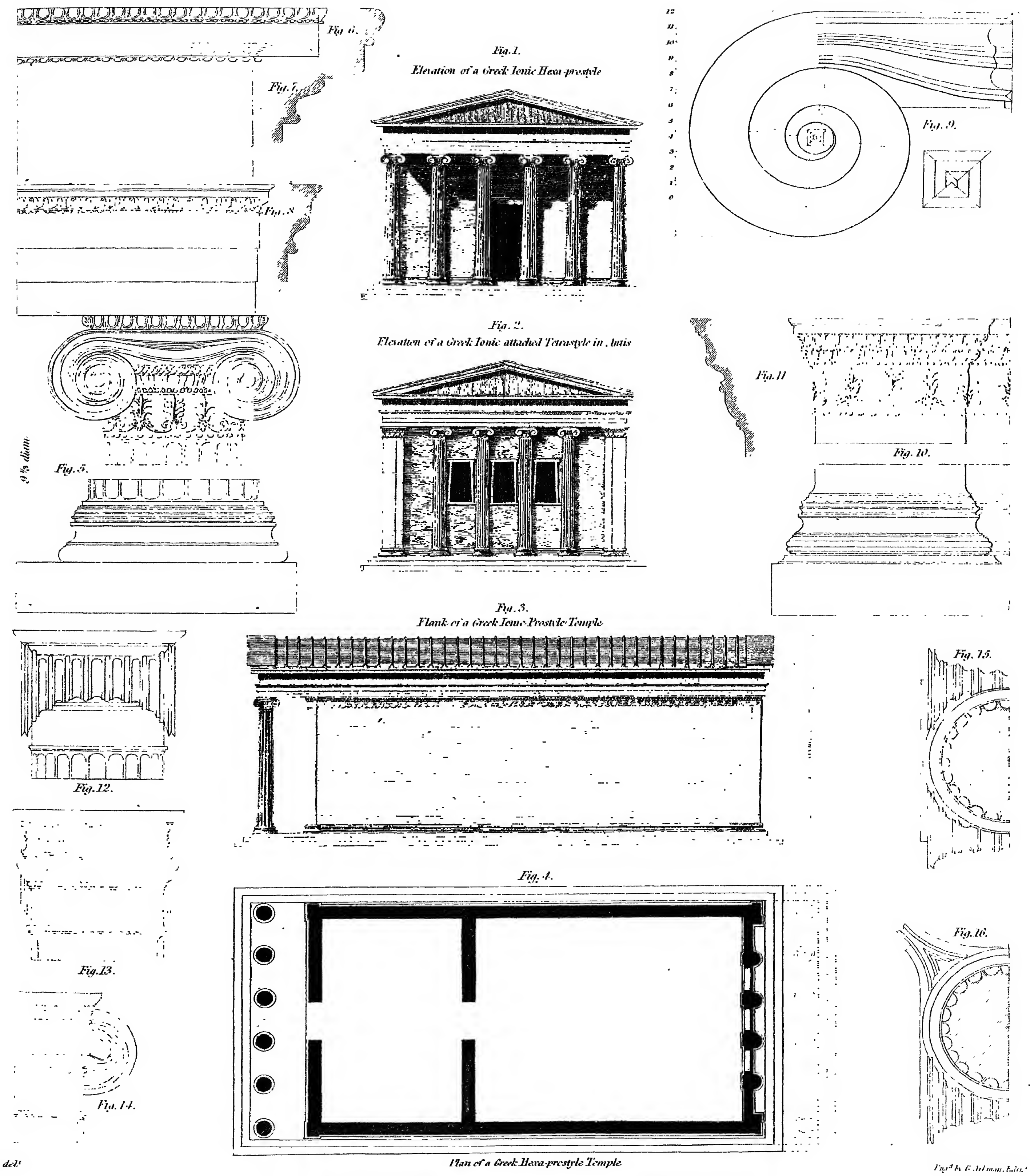


Plan of a Greek Hexastyle-peripteral & Cleithral Temple.

W.H. del.

Published by A & C Black, Edinburgh.

ARCHITECTURE. PLATE LV.

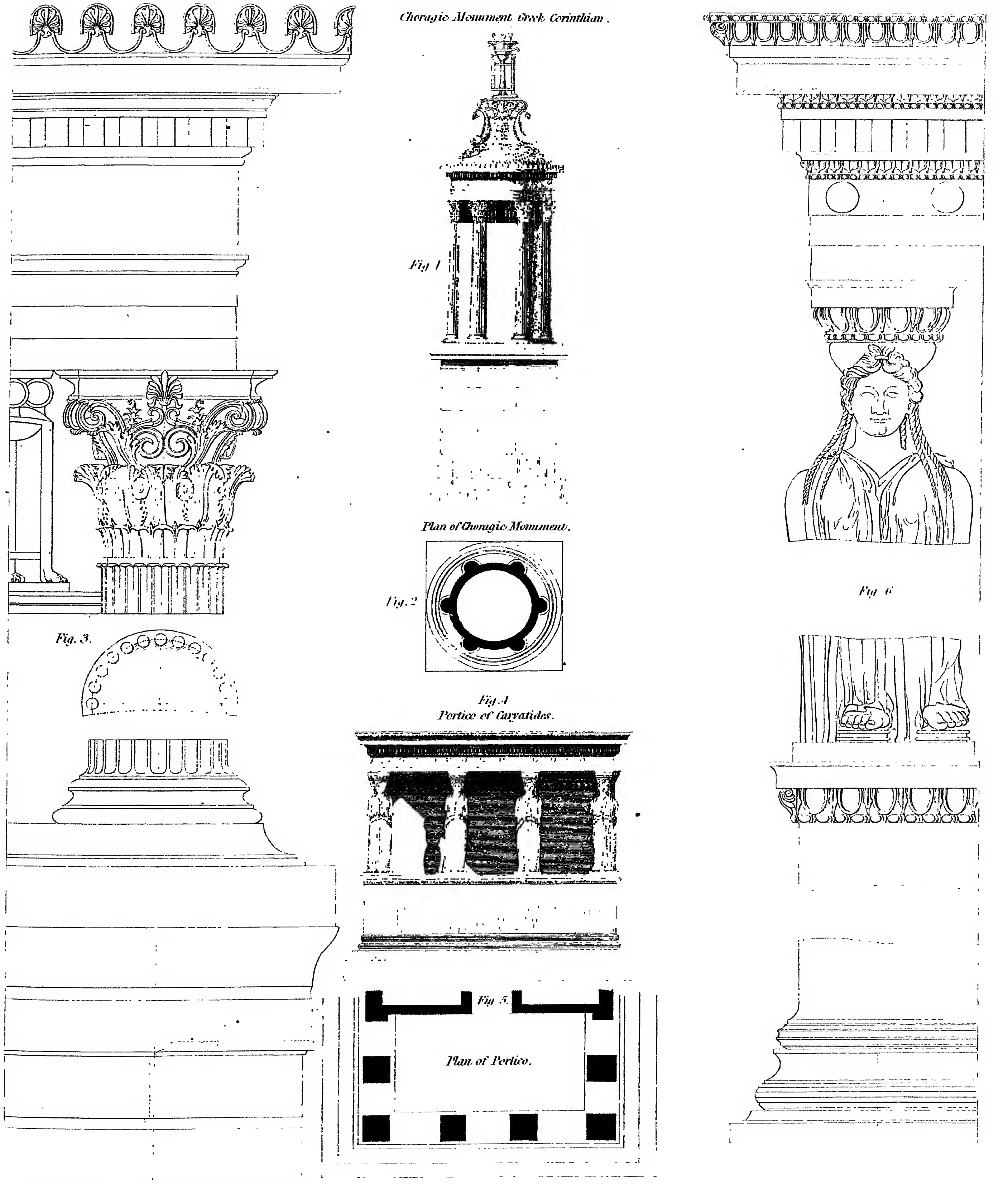


Plan of a Greek Hexa-prestyle Temple

W H delt

Engd by G. Aikman, Edinr

Published by A.& C. Black, Edinburgh



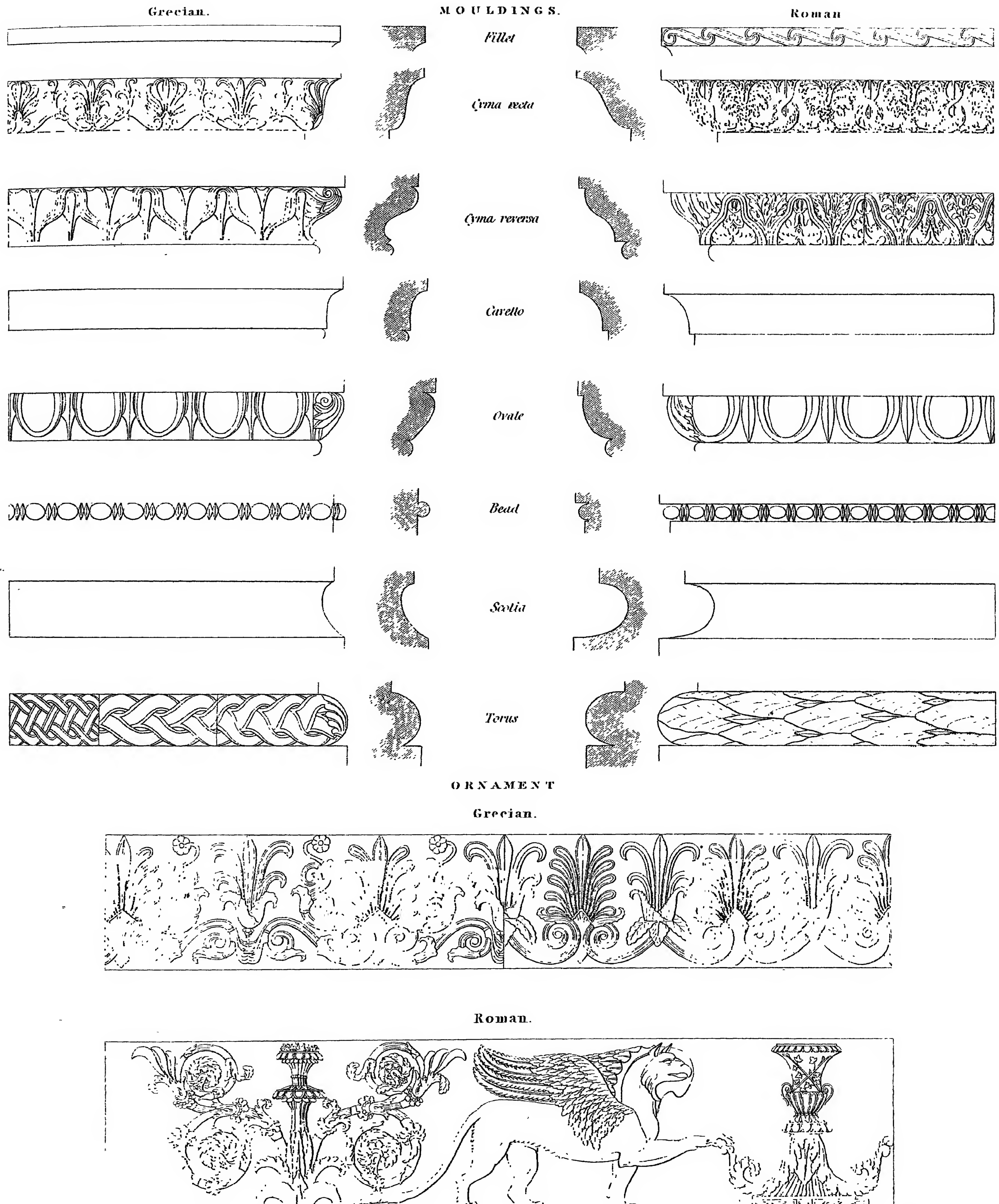
W H del^t

Published by A & C Black Edinburgh

Eng^d by G. Aikman Edin^r

ARCHITECTURE.

PLATE LVII.



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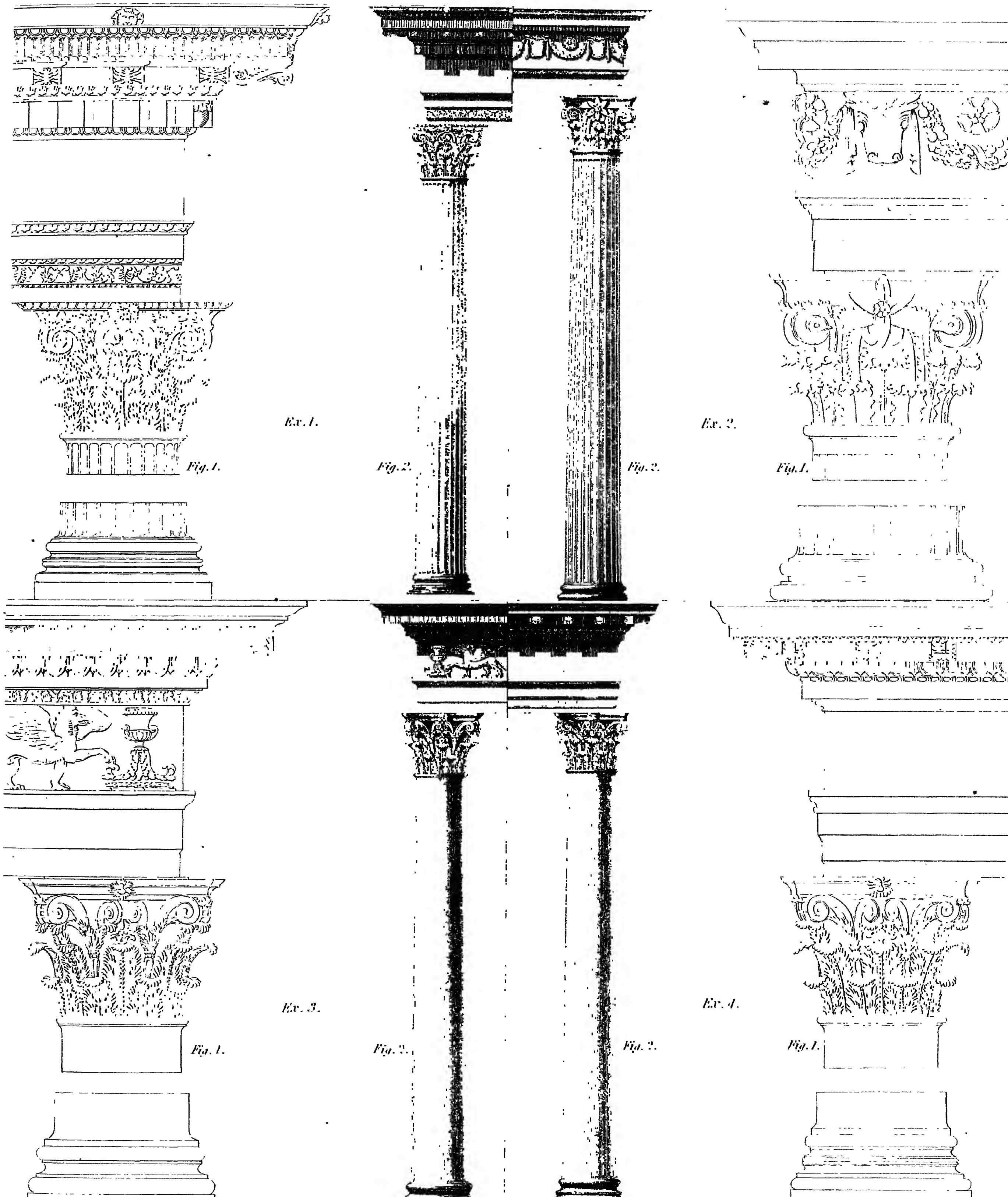
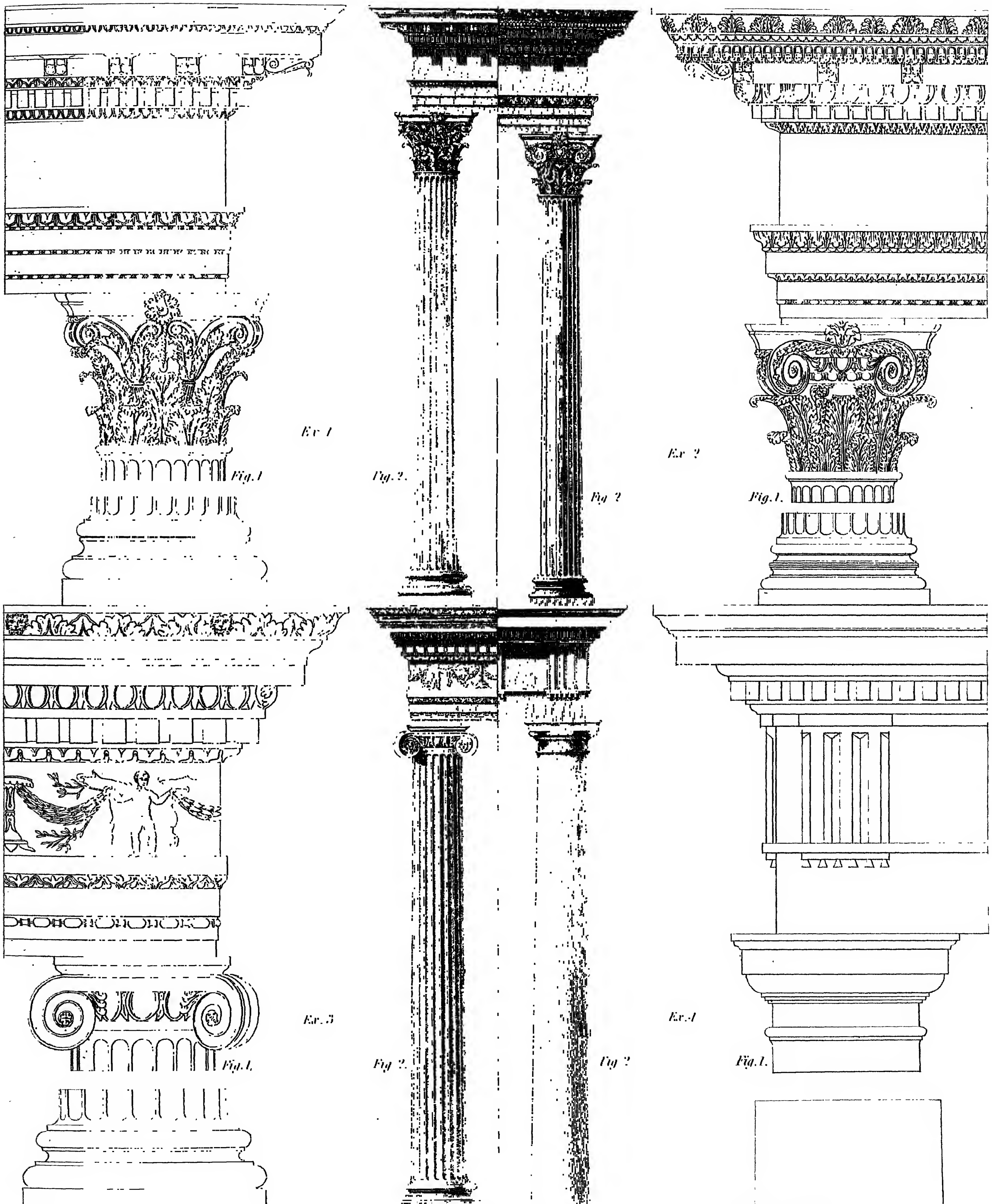
Examples of the Roman Corinthian



Drawn by G. Maddox. Esq.r Archt.

Published by A.& C Black, Edinburgh

Engd by G. Aikman Edinr



Examples of the Roman Orders

Published by A&C Black, Edinburgh

Fig. 1.

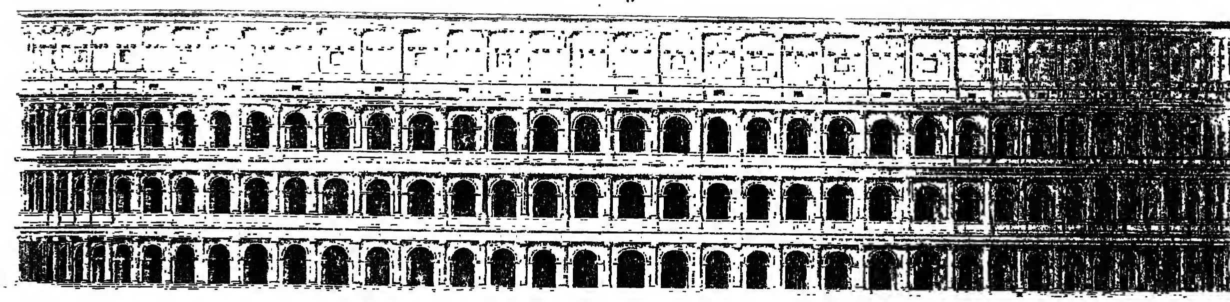


Fig. 2.

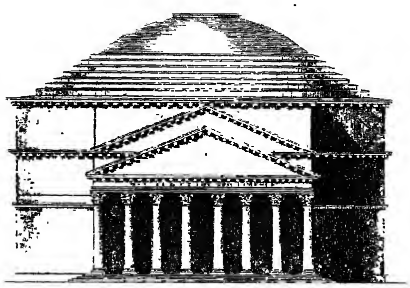


Fig. 3.

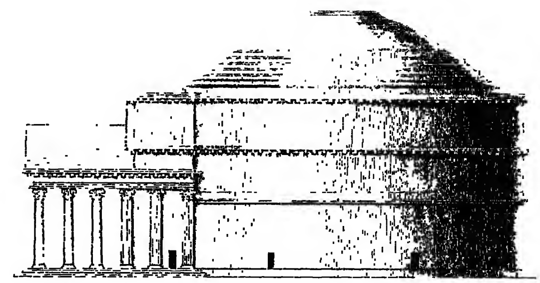


Fig. 4.

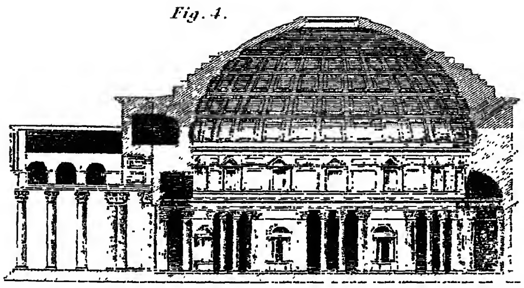


Fig. 5.

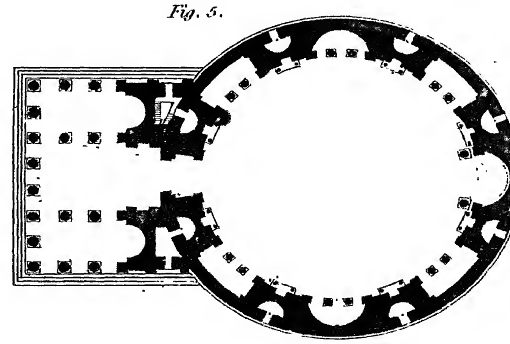


Fig. 6.

Fig. 7.

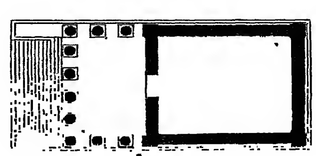


Fig. 8.

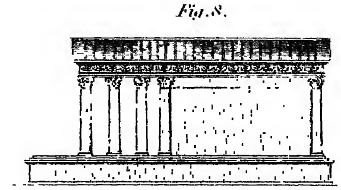


Fig. 9.

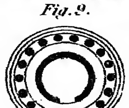


Fig. 10.

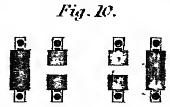
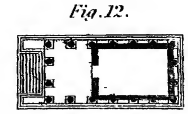


Fig. 11.

Fig. 12.



W.H. del.

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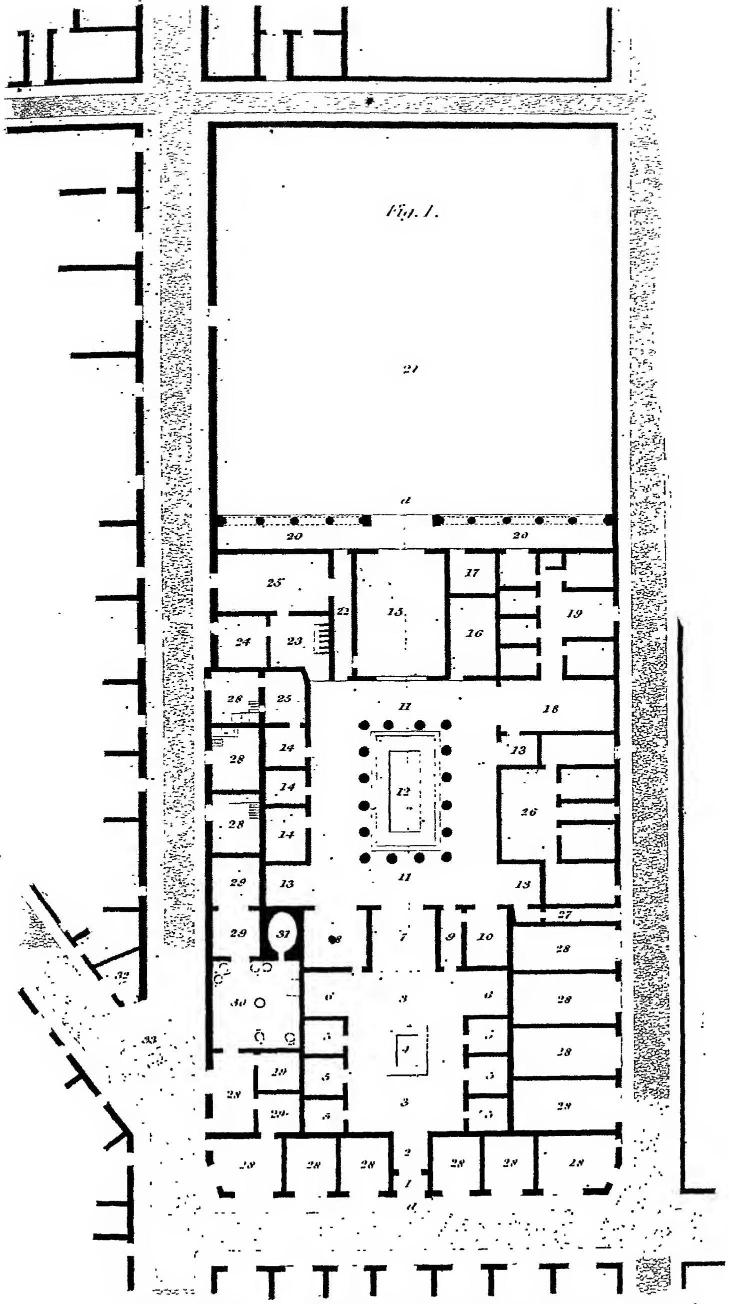
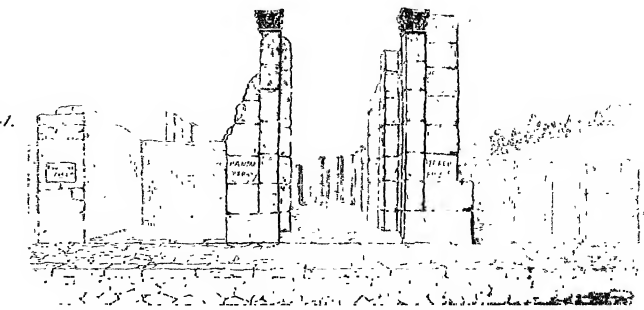
Engd by G. Aikman, Edinr

Fig. 1.



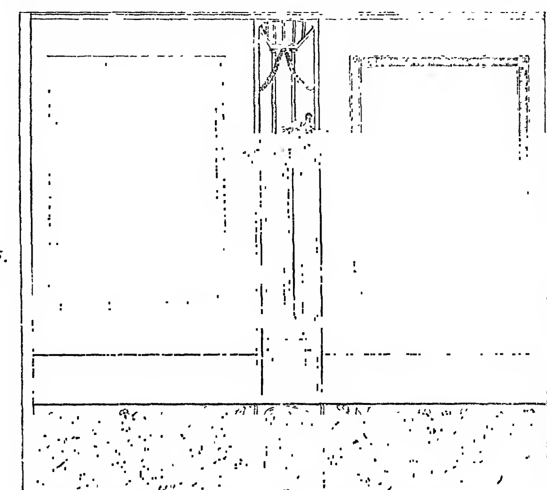
Plan of a Roman Mansion, with the houses, shops & streets, surrounding it. from Pompeii.

Fig. 4.



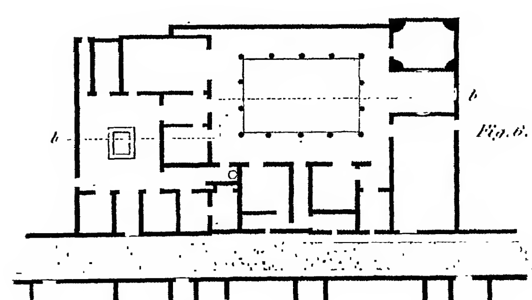
Sketch of the Entrance to the Mansion (Figs. 1. 2 & 3) in its present state.

Fig. 5.



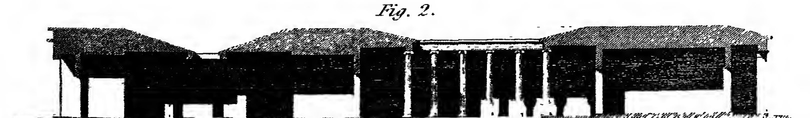
Specimen of the mode of ornamenting the sides of rooms in Pompeii.

Fig. 6.



Plan of a Roman Mansion in a private street. from Pompeii.

Fig. 2.



Section of the above Mansion (Fig. 1) on the line a.a.

Fig. 7.

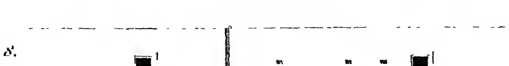
Section of the above Mansion (Fig. 6) on the line b.b.

Fig. 3.

Entrance Elevation to the street of the above Mansion (Fig. 1)

Scale of 10 5 0 10 20 30 40 50 60 70 80 90 100 feet

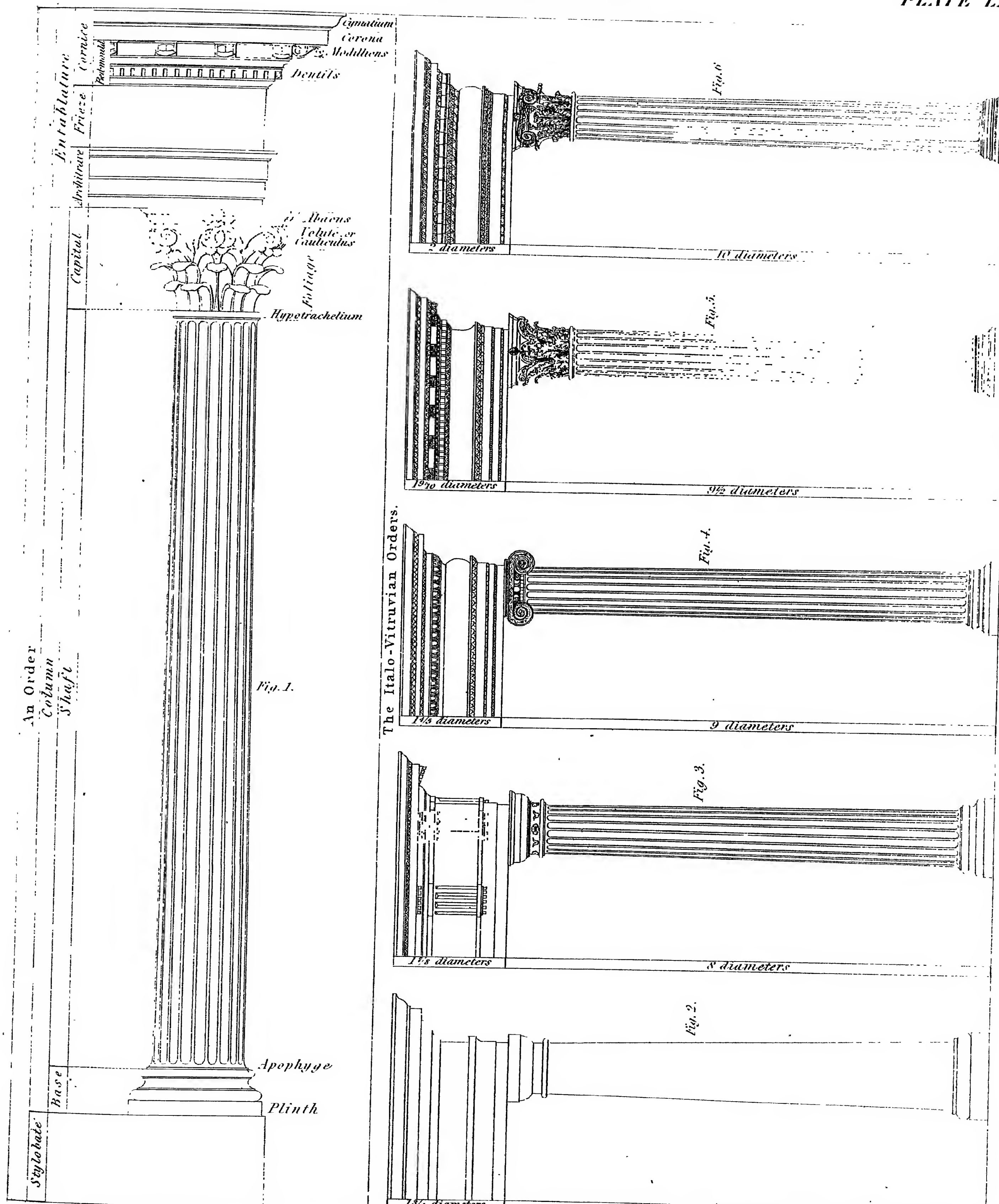
Fig. 8.



Elevation to the street of the above Mansion (Fig. 6)

W. H. delt. Engd. by G. Aikman Edin.

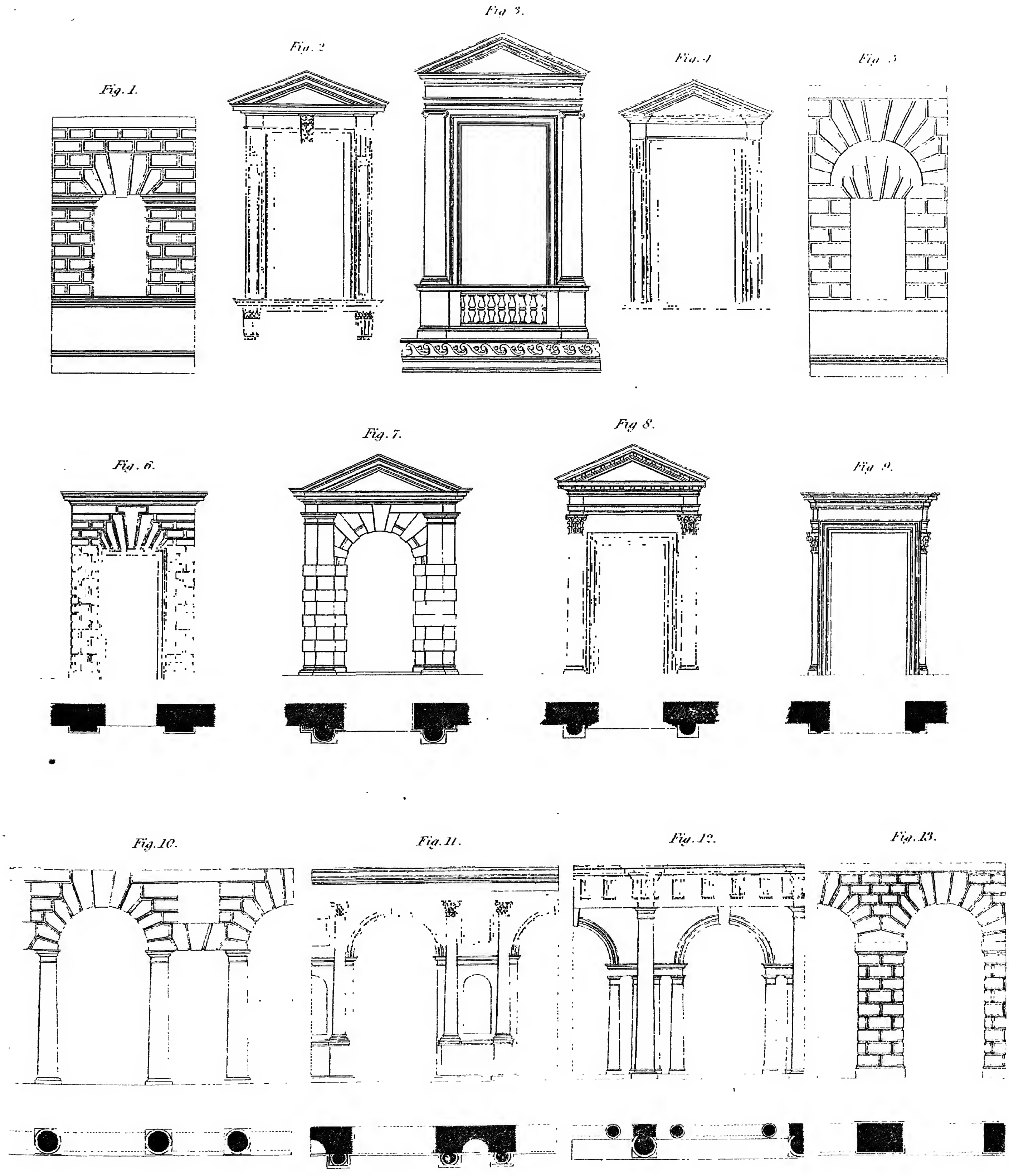
Published by A. & C. Black, Edinburgh



W. H. delt

Engd by G. Aikman, Edinr

Published by A & C Black Edinburgh

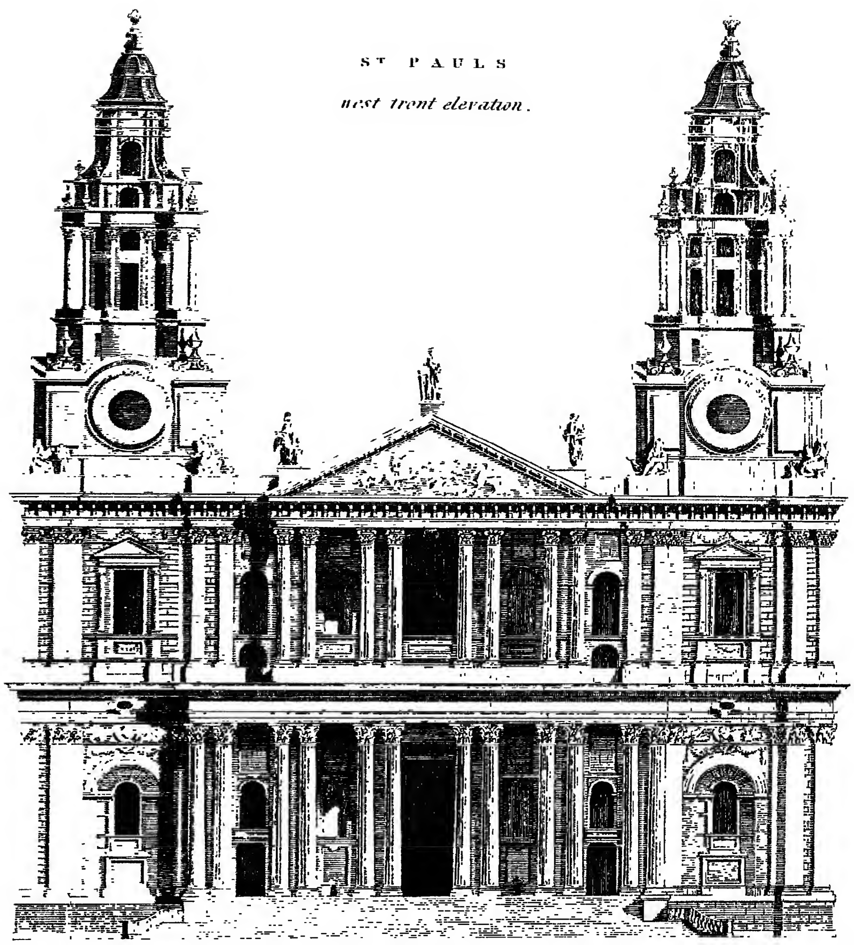


W H. del.

Engd by G Aikman Edin.

St PAULS

west front elevation.



SCALE
10 5 0 10 20 30 40 50 60 70 80 90 100 Feet

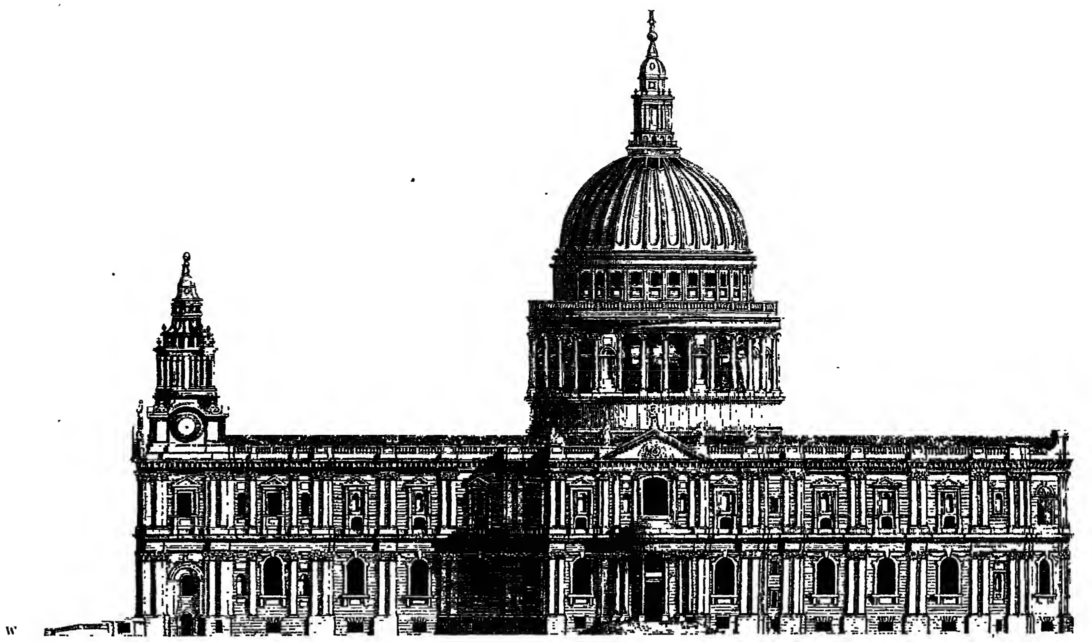
St PETERS.

east front elevation.

Drawn by [illegible] Esqr. Archt.

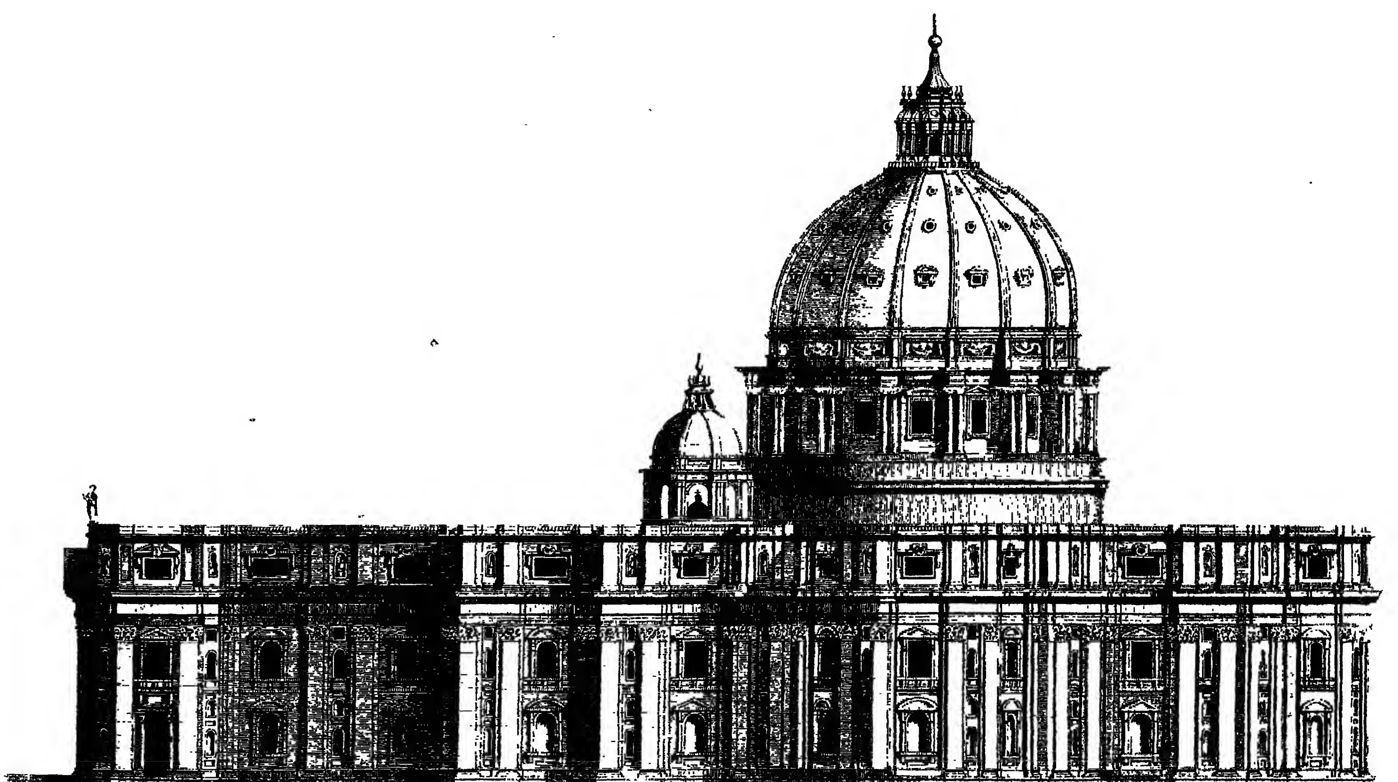
Engd by G. Aikman Edinr

Published by A & C Black Edinburgh



S.T PAUL'S

(South Flank Elevation.)



Drawn by J P Ware Esq.r Arch.t

S.T PETER'S.

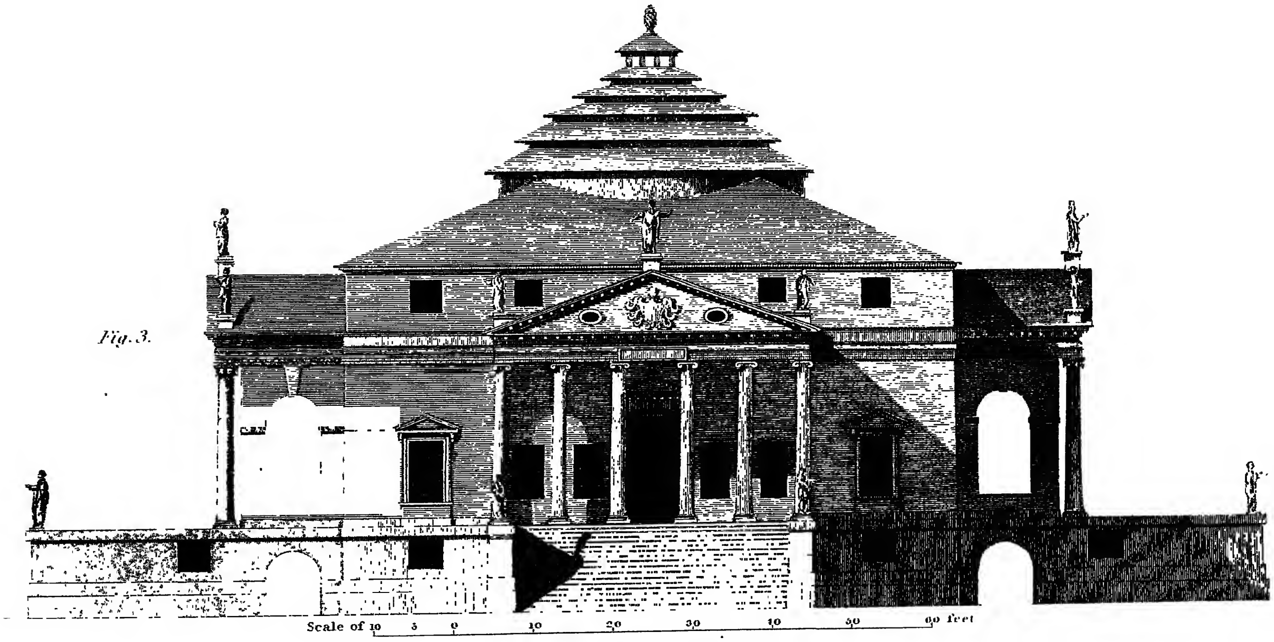
(North Flank Elevation.)

SCALE

0 50 100 200 300 Feet

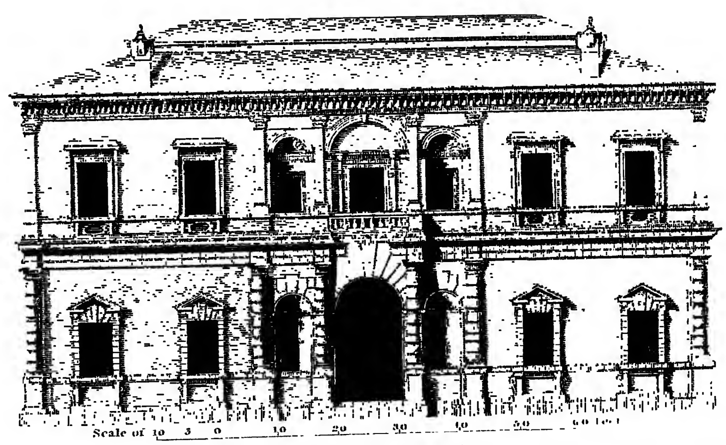
Published by A&C Black, Edinburgh

Fig. 3.



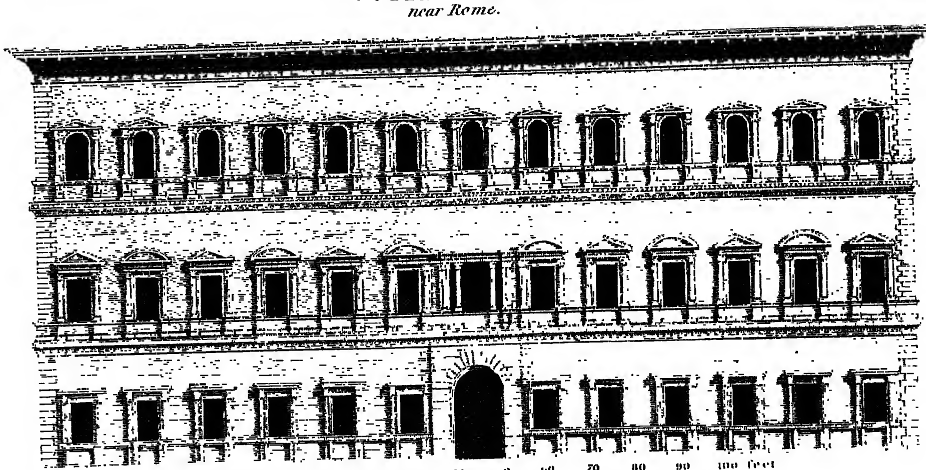
VILLA CAPRA
near Vicenza.

Fig. 2.



VILLA GIULIA
near Rome.

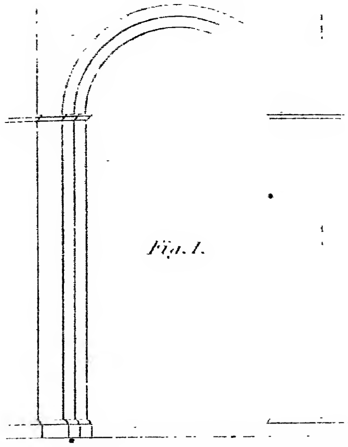
Fig. 1.



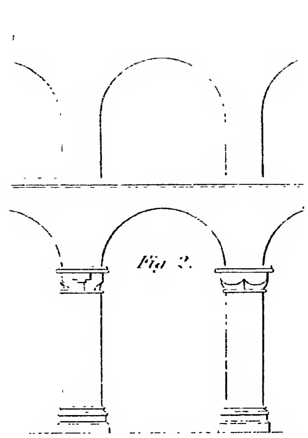
FARNESE PALACE — ROME
Front elevation.

Drawn by J. P. Ware, Esq.r Arch.t *Eng.d by C. [illegible] Edin.r*

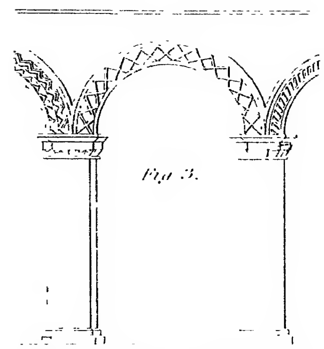
Published by A & C Black, Edinburgh.



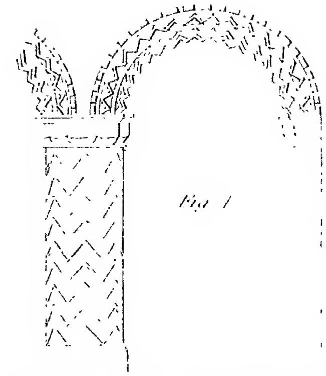
Arch from the Nave of St. Albans Abbey Church.



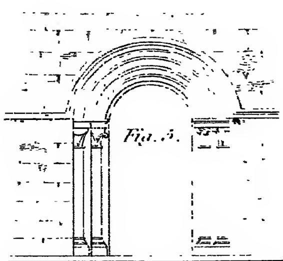
Arches from a Chapel in the White Tower, London.



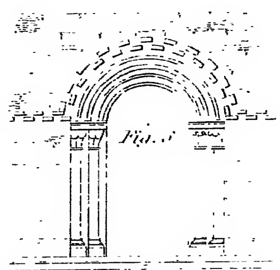
Arches from the Conventual Church Ely.



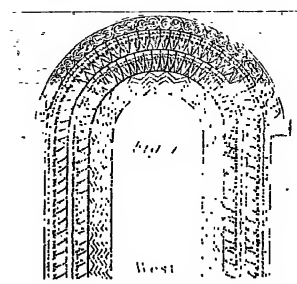
Arches from Waltham Abbey Church, Herts.



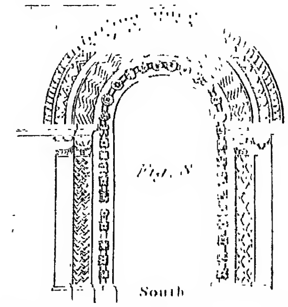
Window from Steyning Church, Sussex.



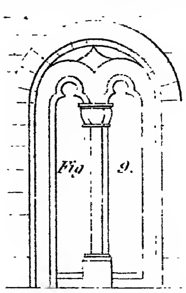
Window from Steyning Church, Sussex.



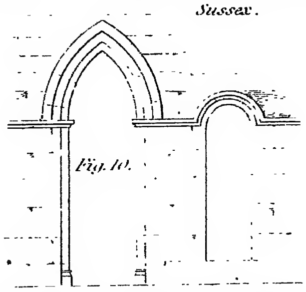
Doorway from Iffley Church, Oxfordshire.



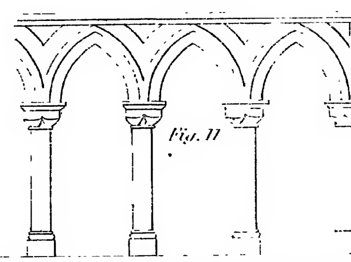
Doorway from Iffley Church, Oxfordshire.



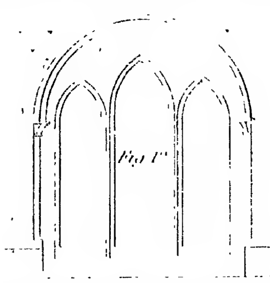
Window from Pythagoras's School, Cambridge.



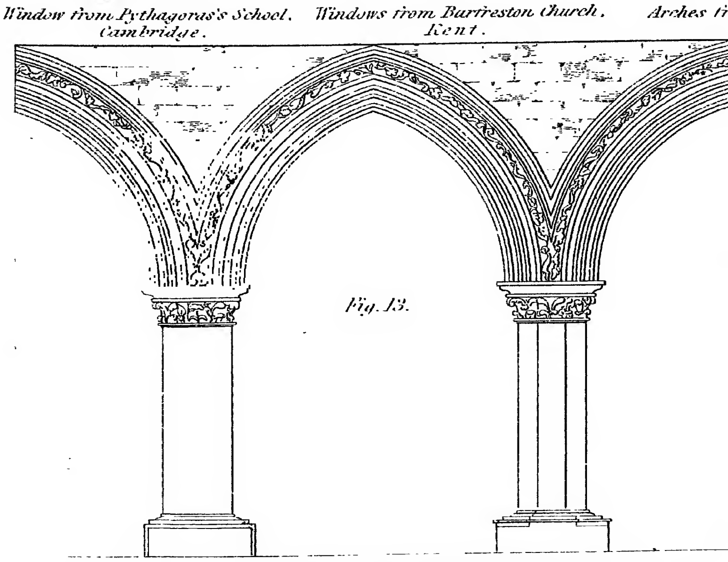
Windows from Barfreston Church, Kent.



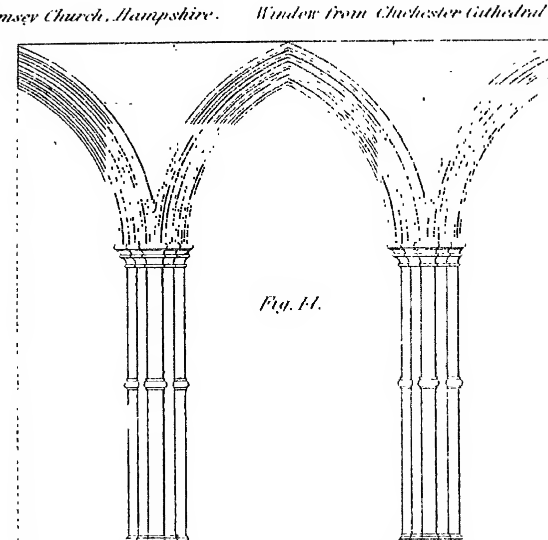
Arches from Romsey Church, Hampshire.



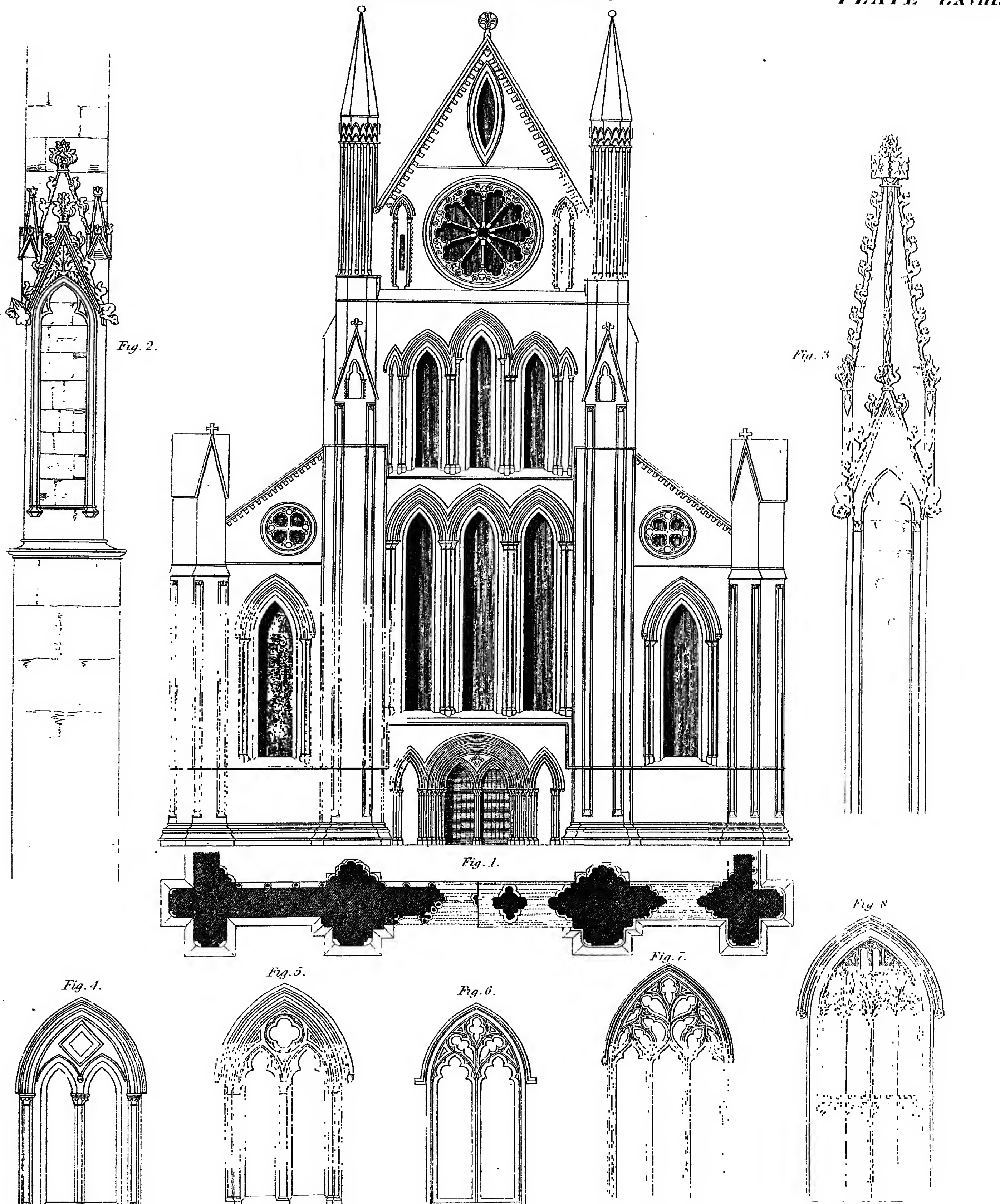
Window from Chichester Cathedral.



Arches from the Nave of Shoreham Church, Sussex.



Arches from the Nave of Salisbury Cathedral.



H. del.

Engd by G. Aikman Edinr

Published by A & C Black Edinburgh

Sectional compartment of the Nave of Lincoln Cathedral

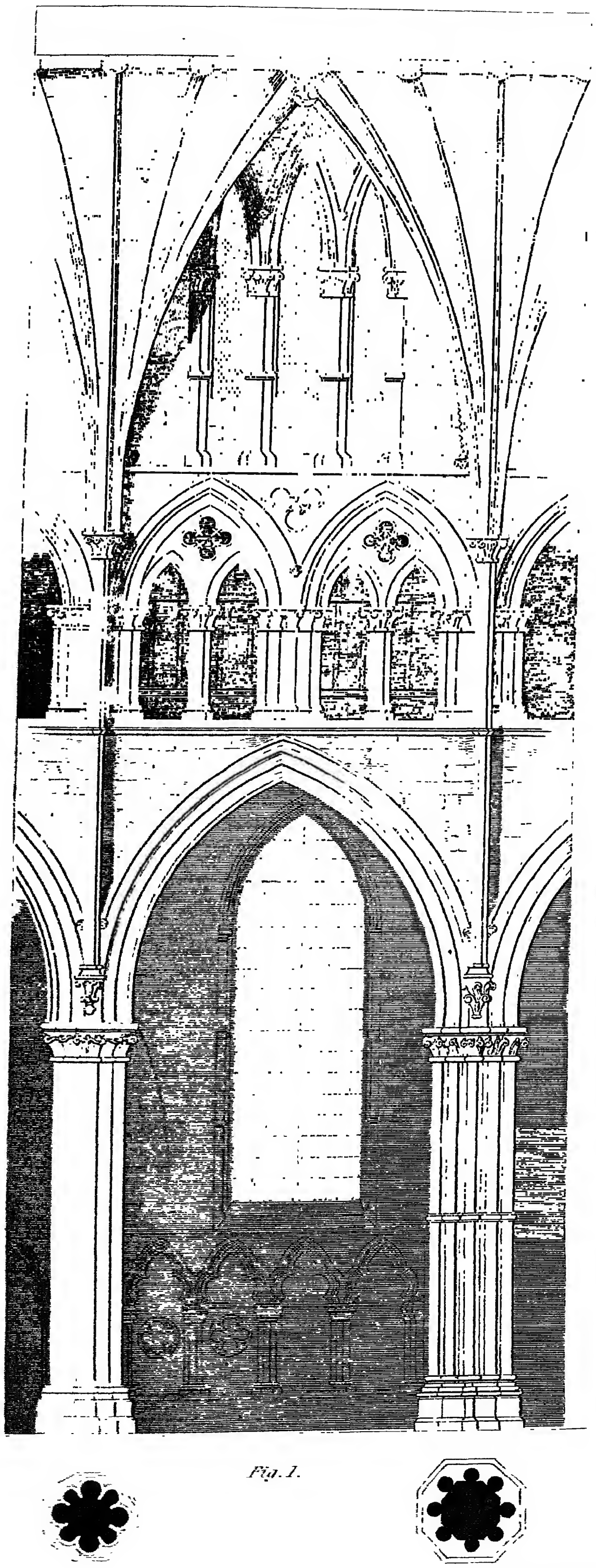


Fig. 1.

Sectional compartment of the Choir of Lincoln Cathedral

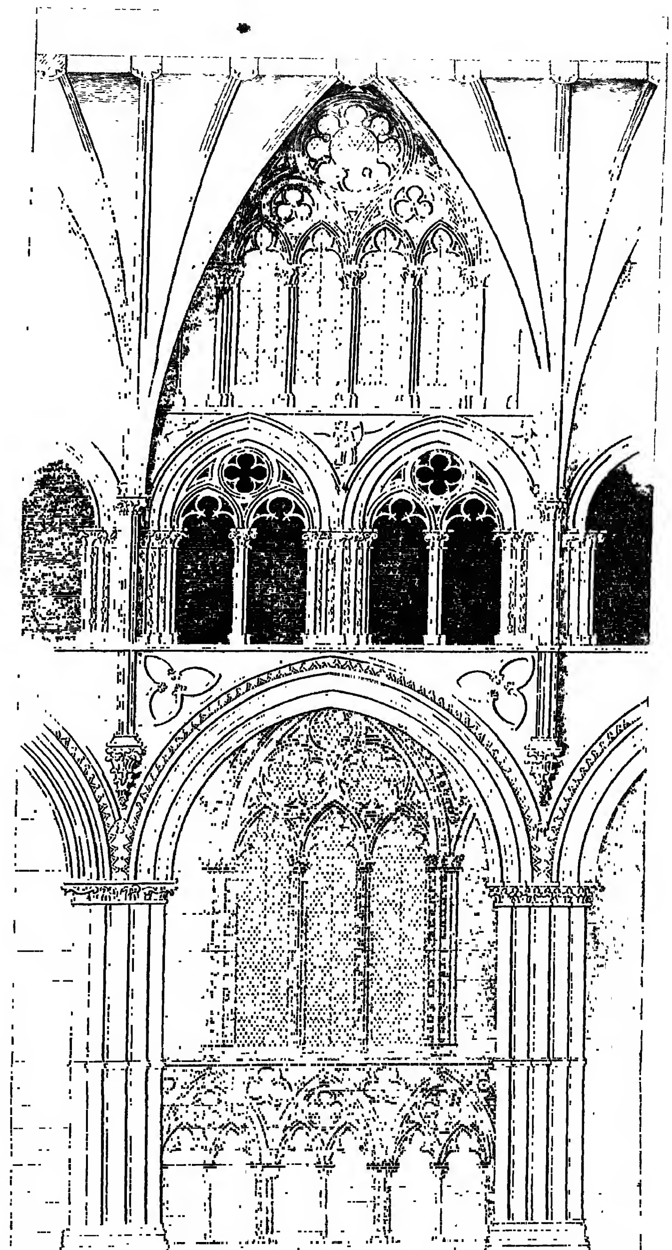
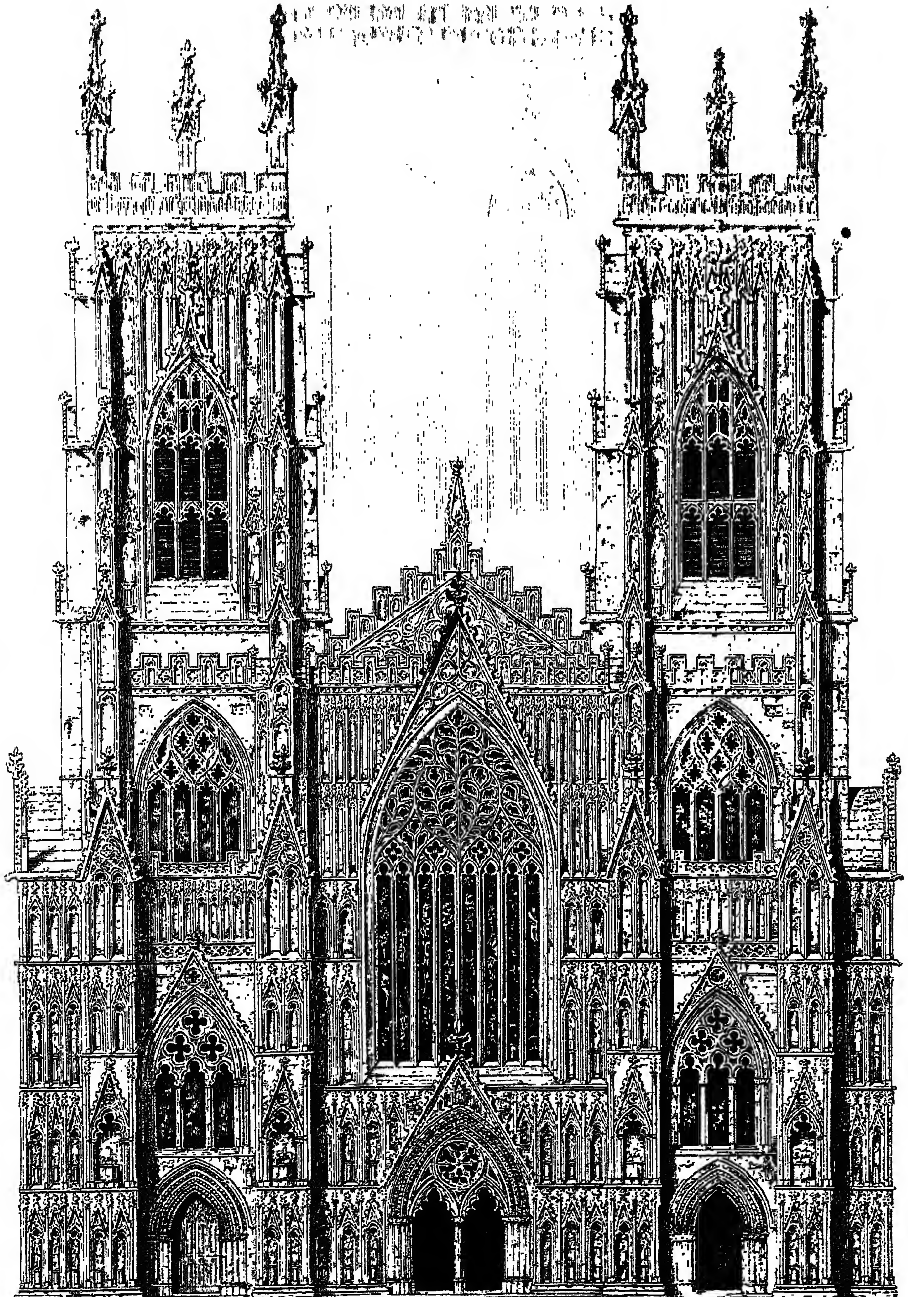


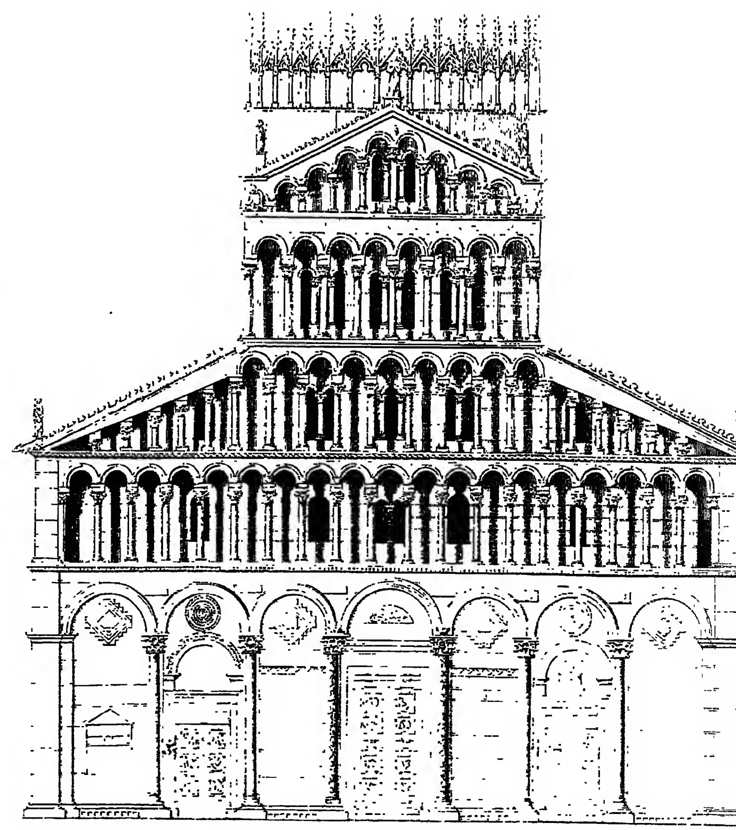
Fig. 2.

Eng^d by G. Aikman, Edin.^r

Published by A. & C. Black, Edinburgh.

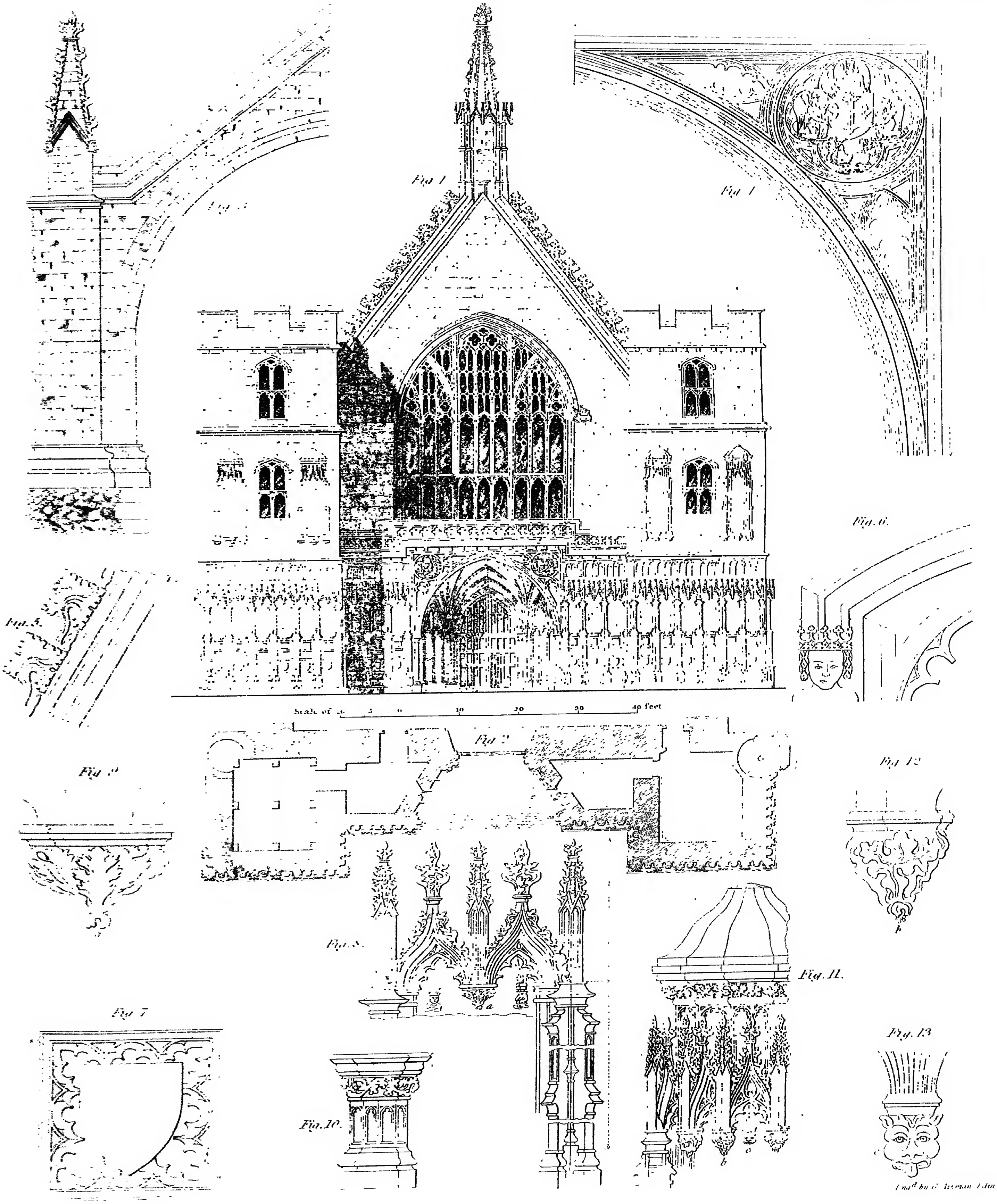


YORK CATHEDRAL

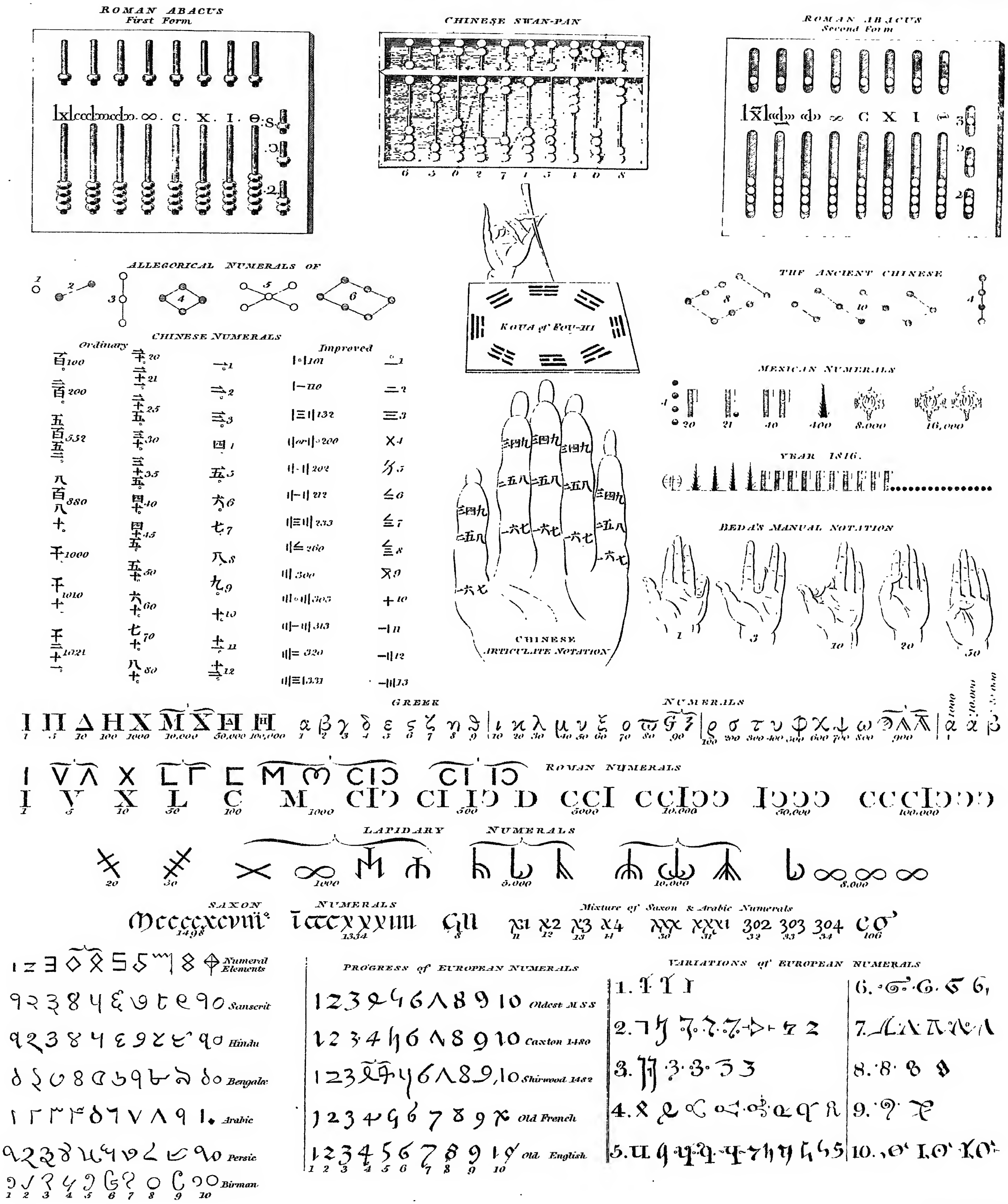


PISA CATHEDRAL.

SCALE



Published by A & C Black Edinburgh



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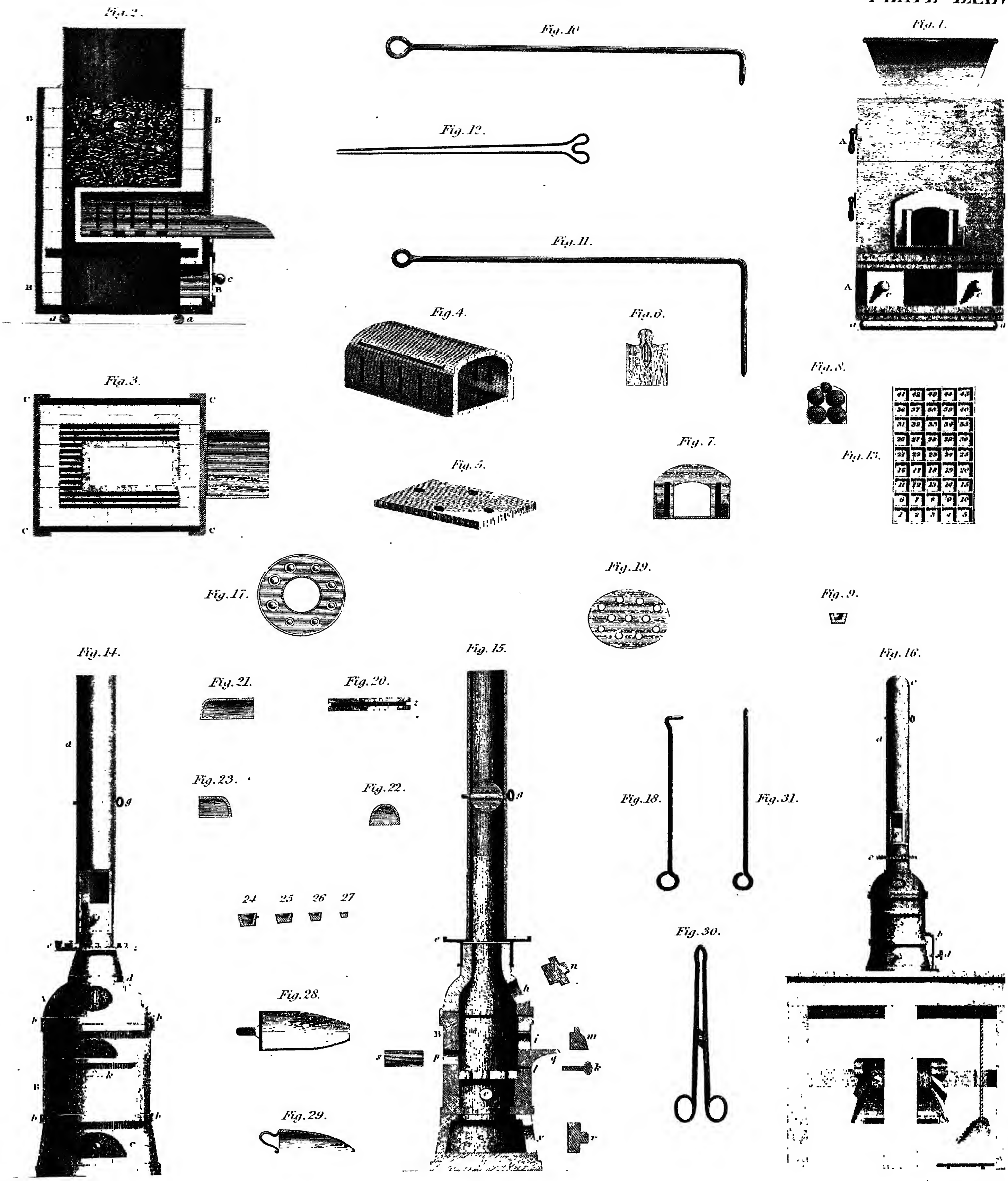
ASSAYING.

PLATE LXXI



J. Farey, del.

Eng^d by G. Aikman

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ASSAYING.

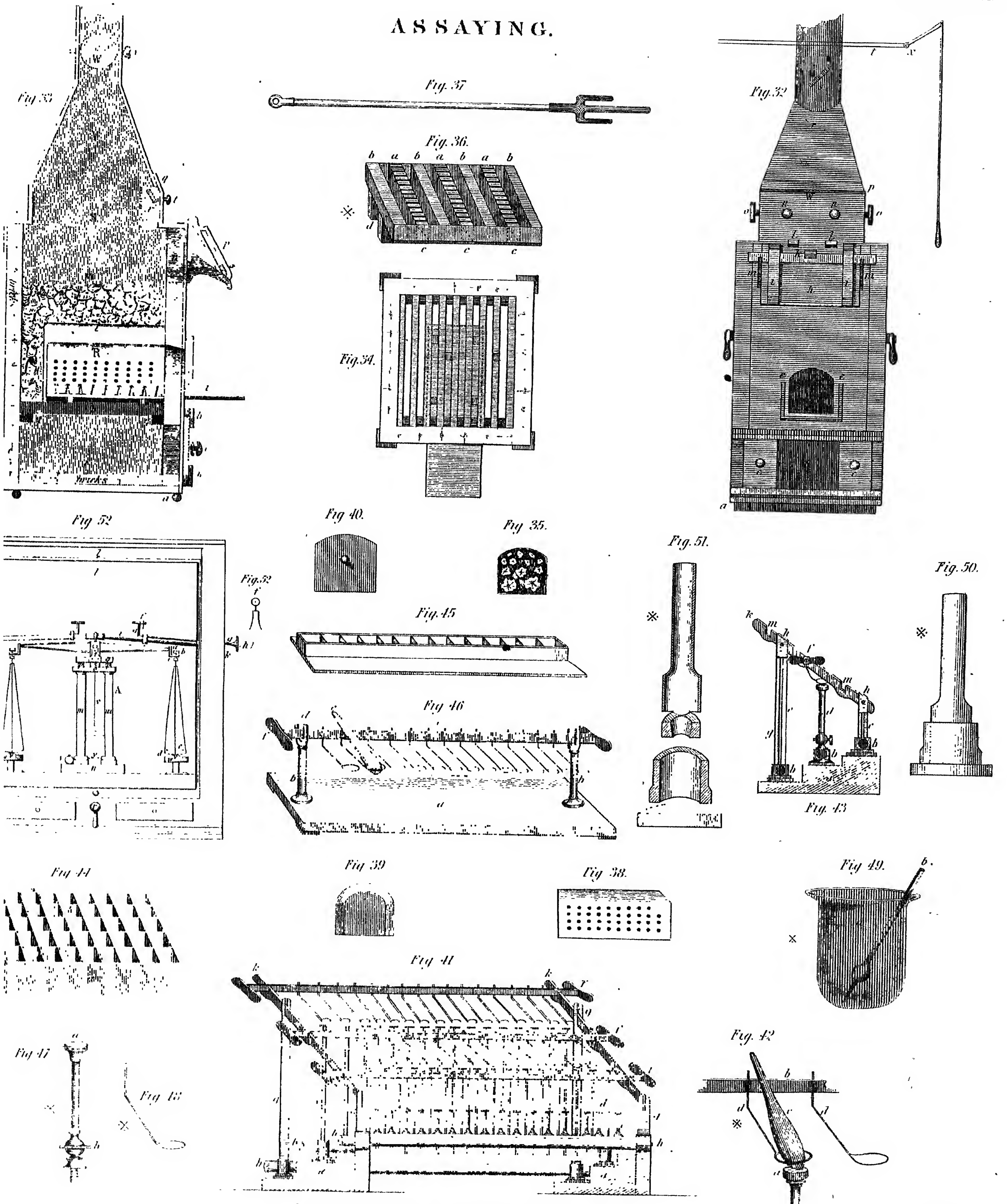
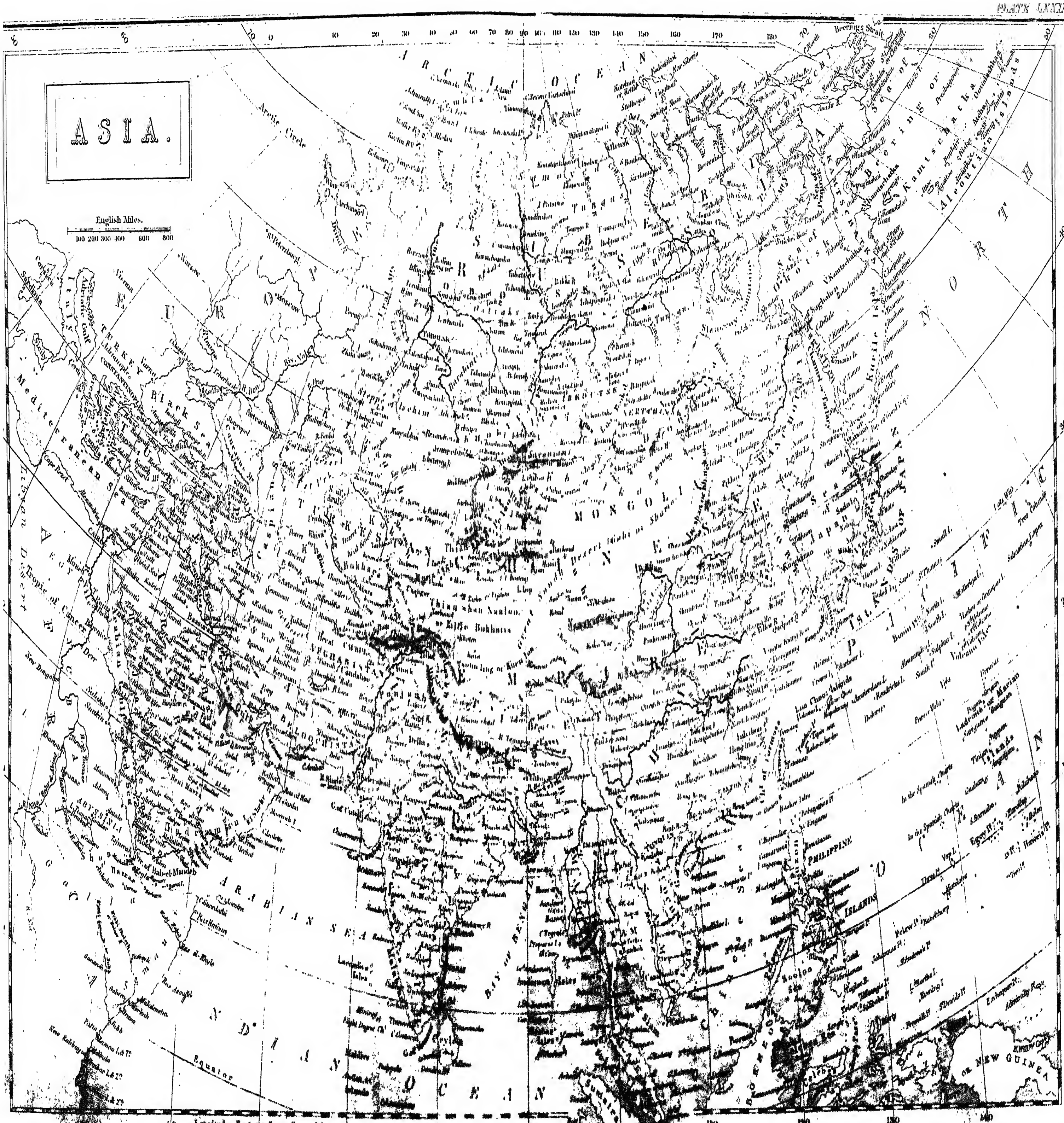


Fig. 33
Fig. 37
Fig. 36.
Fig. 34.
Fig. 32
Fig. 52
Fig. 40.
Fig. 35.
Fig. 51.
Fig. 50.
Fig. 45
Fig. 46
Fig. 43
Fig. 44
Fig. 39
Fig. 38.
Fig. 49.
Fig. 41
Fig. 47
Fig. 48
Fig. 42



Engraved by Sidney Hall